

# NAVAL POSTGRADUATE SCHOOL

## Monterey, California



### THESIS

**PATIENT SATISFACTION:  
A VISUAL ANALYSIS USING TRELLIS GRAPHICS**

by

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September 1998

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19981113 038

<b>REPORT DOCUMENTATION PAGE</b>			Form Approved OMB No. 0704-0188	
Public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instruction, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington, VA 22202-4302, and to the Office of Management and Budget, Paperwork Reduction Project (0704-0188) Washington DC 20503.				
1. AGENCY USE ONLY (Leave blank)		2. REPORT DATE September 1998		3. REPORT TYPE AND DATES COVERED Master's Thesis
4. TITLE AND SUBTITLE PATIENT SATISFACTION: A VISUAL ANALYSIS USING TRELLIS GRAPHICS			5. FUNDING NUMBERS	
6. AUTHOR(S) Hall, Tonya A.				
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Postgraduate School Monterey, CA 93943-5000			8. PERFORMING ORGANIZATION REPORT NUMBER	
9. SPONSORING / MONITORING AGENCY NAME(S) AND ADDRESS(ES)			10. SPONSORING / MONITORING AGENCY REPORT NUMBER	
11. SUPPLEMENTARY NOTES The views expressed in this thesis are those of the author and do not reflect the official policy or position of the Department of Defense or the U.S. Government.				
12a. DISTRIBUTION / AVAILABILITY STATEMENT Approved for public release; distribution is unlimited.			12b. DISTRIBUTION CODE	
<b>ABSTRACT (maximum 200 words)</b> During times of peace, health care is one of the foremost quality of life issues to active duty members, their families and retirees. Patient satisfaction surveys are used to determine how patients perceive salient aspects of their medical care. There has been substantial anecdotal evidence to suggest that patients are unhappy with their care, but past analysis of the DoD Annual Surveys using simple frequencies of responses indicated that, overall, patients were satisfied. This thesis, using a powerful new technique called Trellis Graphics that allows more than three variables to be visualized simultaneously, has uncovered startling results that go beyond previous analysis, provide evidence to support the anecdotal claims, and show that overall satisfaction is not a reliable measurement for determining patient satisfaction. The seven factors defined by the National Committee on Quality Assurance are each individually, and together as a group, more reliable measures. The inability to choose a provider was clearly rated by every beneficiary group as the single greatest source of dissatisfaction. There are also differences in satisfaction between the sexes, and among the different groups. Active duty members, who are the primary customers of military treatment facilities, are the most dissatisfied, and women tend to be less happy than men.				
14. SUBJECT TERMS Patient Satisfaction, Military Health Care, Survey, Trellis Graphics			15. NUMBER OF PAGES 82	
			16. PRICE CODE	
17. SECURITY CLASSIFICATION OF REPORT Unclassified	18. SECURITY CLASSIFICATION OF THIS PAGE Unclassified	19. SECURITY CLASSIFICATION OF ABSTRACT Unclassified	20. LIMITATION OF ABSTRACT UL	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)  
Prescribed by ANSI Std. Z39-18



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Submitted in partial fulfillment of the  
requirements for the degree of

**MASTER OF SCIENCE IN OPERATIONS RESEARCH**

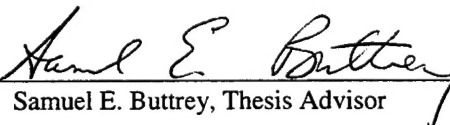
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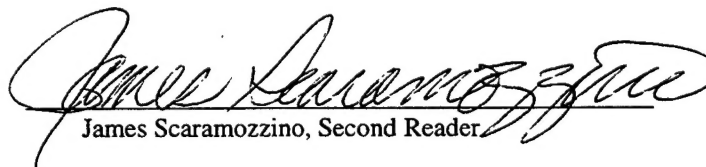
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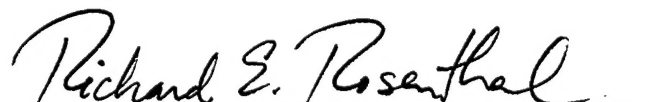
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## **ABSTRACT**

During times of peace, health care is one of the foremost quality of life issues to active duty members, their families and retirees. Patient satisfaction surveys are used to determine how patients perceive salient aspects of their medical care. There has been substantial anecdotal evidence to suggest that patients are unhappy with their care, but past analysis of the DoD Annual Surveys using simple frequencies of responses indicated that, overall, patients were satisfied. This thesis, using a powerful new technique called Trellis Graphics that allows more than three variables to be visualized simultaneously, has uncovered startling results that go beyond previous analysis, provide evidence to support the anecdotal claims, and show that overall satisfaction is not a reliable measurement for determining patient satisfaction. The seven factors defined by the National Committee on Quality Assurance are each individually, and together as a group, more reliable measures. The inability to choose a provider was clearly rated by every beneficiary group as the single greatest source of dissatisfaction. There are also differences in satisfaction between the sexes, and among the different groups. Active duty members, who are the primary customers of military treatment facilities, are the most dissatisfied, and women tend to be less happy than men.



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## EXECUTIVE SUMMARY

During times of peace, health care is one of the foremost quality of life issues to active duty members, their families and retirees. Patient satisfaction surveys are used to determine how patients perceive salient aspects of their medical care. There has been substantial anecdotal evidence to suggest that patients are unhappy with their care, but past analysis of the DOD Annual Surveys using simple frequencies of responses indicated that, overall, patients were satisfied. This thesis, using a powerful new technique called Trellis Graphics that allows more than three variables to be visualized simultaneously, has uncovered startling results that go beyond previous analysis, provide evidence to support the anecdotal claims, and show that overall satisfaction is not a reliable measurement for determining patient satisfaction. The seven factors defined by the National Committee on Quality Assurance are each individually, and together as a group, more reliable measures. The inability to choose a provider was clearly rated by every beneficiary group as the single greatest source of dissatisfaction. There are also differences in satisfaction between the sexes, and among the different groups. Active duty members, who are the primary customers of military treatment facilities, are the most dissatisfied, and women tend to be less happy than men.

This thesis provides a new technique for analysis of complex surveys and attitudinal studies that could have far-reaching impact on how surveys are analyzed throughout the Department of Defense. Surveys are the central tool used within DOD for measuring intangible factors such as attitudes, feelings, and quality of life issues. Almost all

surveys in DOD use Likert scales that is, they collect discrete ordinal responses. The accepted analysis of an ordinal scale survey is to use simplistic frequency tables or to use logistic regression for more advanced work. Logistic regression for the patient satisfaction data is unsatisfactory because of the huge models that resulted from the complex interactions among the demographic and the measurement variables. At this point, after the accepted types of analysis were used and failed, a relatively new graphing technique called Trellis Graphics was adapted to understand the complex interactions that were occurring within the data. This technique allows the user to look past the three-dimensional barrier and visualize the hypervariate data in four and five dimensions. This graphics technique had previously been used to analyze agriculture and environmental measures, not attitudinal surveys. The results were both clear and useful. One important impact of the research found an area of major dissatisfaction among active duty members and discovered a possible flaw in the DOD survey design. The most significant impact of this research is putting into practice a new method that introduces a fundamentally new approach to analysis of survey results, never before considered. Both the analyst and the end user can visualize the data, which adds confidence to the decision-maker and enhances the overall benefit of the analysis. Trellis graphics could be used by all of the military services to analyze and amplify the underlying foundations of attitudes and feelings for many of the quality of life issues such as retention, housing, pay, and medical care. It is these issues that DOD and the Congress have realized are vitally important to preserving today's peacetime military force at its highest levels of readiness. The technique introduced herein, can make a significant contribution to the understanding of

those issues and ultimately enhance decision maker's ability to improve the quality of life for all members of the military community.





## I. INTRODUCTION

The Department of Defense operates one of the nation's largest healthcare complexes, with nearly 8.3 million individuals eligible to receive care through the Military Health System. Since the end of the Cold War, the U.S. military has seen manpower reductions, which have changed the role of military medicine. Since the Department of Defense began its downsizing, the number of doctors, nurses and medical technicians has declined by as much as 50 percent in some locations. Furthermore, the Base Realignment and Closure Commission (BRAC) recommended closing a number of installations that are no longer needed. As a result of this and other downsizing efforts, 35 percent of the military hospitals that existed in the U.S. in 1997 have closed. However, the total number of people seeking healthcare through the MHS has dropped by only 9 percent. (OSD 1997)

In order to mitigate the possible decline in the ability to care for its patients, the Military Health System (MHS) must examine itself in this environment and move toward the standards set by the civilian healthcare industry. These standards are outlined by two of the most prominent healthcare accrediting bodies: the Joint Commission of Accreditation of Health Care Organization (JCAHO) and the National Committee on Quality Assurance (NCQA). One of the most important standards detailed by these accrediting organizations and the focus of this paper is the measurement of a patient's satisfaction. In the future when all hospitals, military and civilian, have virtually the same kind of healthcare products, the distinguishing factor that will ensure an organization's survival will be its attention to high-value customer services (Nelson 1991). Therefore, in addition to high-quality healthcare products, patient satisfaction will be the key ingredient for an organization to be competitive (Nelson 1991).

In a recent study for the White House office of Consumer Affairs it was claimed:

- “96 percent of unhappy customers never complain about rude or discourteous treatment, *but*
- 90 percent or more who are dissatisfied with the service they receive will not buy again or come back. *Worse still,*
- Each of those unhappy customers will tell his or her story to at least nine other people, *and*
- 13 percent of those unhappy former customers will tell their stories to more than twenty people.” (Desatnick 1987)

The U.S. healthcare industry in general, including the MHS, is undergoing sweeping changes. The healthcare industry is experiencing a shift in focus from specialty providers to medical generalists, from inpatient to outpatient care, and from traditional indemnity insurance to prepaid health plans. As the Military Health System moves towards the future, its leaders have many challenges facing them. Ensuring customers are satisfied with the products from both the military hospitals and the network of civilian providers will be the key to providing care for beneficiaries.

#### **A. PURPOSE AND STRUCTURE OF THESIS**

Patient satisfaction has been shown to be positively correlated to treatment compliance, decreasing no-show appointments, better outcomes, and decreased disenrollment from health plans (Cleary 1989). The primary objective of this paper is to determine if there are key areas such as: 1) access to healthcare, 2) choice of providers and continuity of care, 3) perceptions of technical competence of providers, 4) overall quality of healthcare, 5) communication between providers and patients, 6) perception of being able to get help with financial needs, and 7) interpersonal skills of the providers, that may help military medical facilities improve patient satisfaction. A second area of interest is whether there are distinct differences in satisfaction between men and women

in the different regions. Finally, there is interest in whether there are differences in satisfaction among the four military beneficiary groups: 1) active duty personnel, 2) family members of active duty personnel, 3) retirees, their family members, and survivors under age 65, and 4) retirees, their family members, and survivors, age 65 and over.

Access was of primary importance to each of the four beneficiary groups in the 1994-95 Annual Survey. In addition to access, having the freedom to choose one's doctor and location of care may be of great importance to military beneficiaries. As outlined in chapter 55 of Title 10 United States Code, the eligibility status of the individual plays a role in determining the location of care he or she may obtain from either the civilian sector or a military facility, thereby affecting his or her choice of provider.

This thesis will begin by providing some examples of how other organizations have been using customer patient satisfaction surveys. Chapter II gives an introduction to the Military Health Systems' benefit plan and provides an overview of the types of medical plans members may choose. Then Chapter III will give a brief description of earlier work on patient satisfaction, discuss a working definition of patient satisfaction and, of special importance, present an overview on how the National Committee for Quality Assurance (NCQA) has defined patient satisfaction. Chapter IV will describe the 1996 Health Care Survey of DoD Beneficiaries Form A and the analysis of the survey. Chapter V will describe the results of logistic regression and the relatively new visualization technique of Trellis Graphics using a subset of the 1996 survey data. And lastly, Chapter VI discusses the implications of the analysis and gives conclusions and recommendations.

## **B. CUSTOMER SURVEYS**

Customer surveys have been used as a primary tool in both the military and civilian markets for assessing whether patients are satisfied with the different aspects of their medical care. In the past, patient satisfaction surveys were primarily used by hospitals and managed care organizations as marketing tools (Kennedy 1996). Many organizations were comfortable with a fairly low response rate, while some organizations even appeared to believe that simply giving a patient a survey indicated that the organization cared about the patient's opinion, regardless of whether or not the survey results were actually used (Kennedy 1996). In today's competitive environment and with healthcare costs rising, hospitals and managed care organizations are now realizing they need more reliable and useful data from patient satisfaction surveys.

Four primary conditions have prompted the change in this direction and redesign of surveys. First, and foremost, the Joint Commission of Accreditation of Hospital Organizations and the National Committee on Quality Assurance have released standards requiring organizations to continuously measure patient satisfaction. These measures are to provide data and feedback to both the consumers and purchasers of healthcare. The second condition is that healthcare is becoming increasingly competitive and costly which leads to a heavy emphasis on the resulting quality of healthcare services. Thirdly, the patient's viewpoint has become much more important and relevant in the adoption of continuous quality improvement methods and programs. Lastly, employers as purchasers of healthcare are demanding information on satisfaction, costs, doctor/patient relations, convenience and accessibility for their employees. (Kennedy 1996)

Several prominent organizations have used patient satisfaction surveys successfully and have been able to link customer judgments with process measures. One example of this is the Henry Ford Medical Group, one of the largest group medical practices in the United States that specializes in primary care, located in Detroit, Michigan. This organization was able to use a survey to identify problems that their customers had with access. Two of the major problems identified were that patients could not get through on the telephone to obtain one of the limited number of appointments, and that they had to wait for long periods of time between scheduling an appointment and seeing the doctor. The Group used a survey to ask their patients about key issues that influenced their overall satisfaction. The survey results showed that the significant determinants for satisfying their patients, were ease of scheduling appointments, being able to see a specialist when needed, having a shorter waiting time to see a doctor, and the ability to obtain medical advice via phone. (Anctil 1996)

In another study, a survey was conducted on inpatient care at Brigham and Women's Hospital in Boston. The intent of the study was to seek general information about patient satisfaction, and to investigate relationships between overall satisfaction and characteristics such as age, gender, health status, source of payment and location in the hospital where the patients' received care. The Brigham and Women's Hospital found that for inpatient care, perceived health and their satisfaction with nurses and physicians were the two strongest indicators of patient satisfaction. (Cleary 1989)



## **II. MILITARY HEALTH SYSTEM**

### **A. CURRENT HEALTH BENEFITS PLAN**

The Military Health Services' primary mission is to maintain the health of its active duty service personnel and to be prepared to deliver health care during times of war. In addition to its primary mission, the MHS, as an employer, offers health care services to non-active duty beneficiaries. Title 10, U.S.C. Chapter 55, Sections 1071-1106 outline the entitlement programs for the Uniformed Services and establishes the eligibility requirements for the MHS. The healthcare services are provided through a system of medical centers, smaller hospitals, and clinics worldwide, and through a DoD-administered insurance-like program called the Civilian Health and Medical Program of the Uniformed Services (CHAMPUS). CHAMPUS is automatically available to families of active duty personnel, retirees and their dependents and survivors under the age of 65. At age 65, beneficiaries are no longer eligible for CHAMPUS because they become eligible for Medicare. (TSO 1997)

In the 1980's, MHS faced CHAMPUS costs which grew 350 percent while the national health expenditures increased by only 166 percent during the same period. In response to the escalating costs, DoD, with congressional authorization, has been testing alternative approaches for delivering healthcare such as managed care which emphasizes keeping the patient healthy through preventive care and services rather than simply treating the patient when he or she becomes ill. (GAO 1995)

The purpose of converting the MHS to a managed care system was to provide quality care while improving access and containing costs. This initiative toward managed care in the MHS evolved over several years. The Fiscal Year 1988 Defense Authorization Act



(Public Law 100-180) initiated this effort by mandating demonstration projects be implemented to improve quality and contain costs in the MHS. These projects included the CHAMPUS Reform Initiative in Hawaii and California (CRI), Catchment Area Management Demonstration Projects, and the U.S. Army's "Gateway to Care" program implemented in 1991. All of these initiatives were developed to contain the rapidly rising healthcare costs for CHAMPUS, to maintain or improve the quality and accessibility of patient care, and to improve both beneficiary and Military Treatment Facility (MTF) staff satisfaction. However, under some of the demonstration projects, costs actually increased: in the case of CRI, for example, by 4.6 percent from 1988 to 1989. The Assistant Secretary of Defense for Health Affairs addressed the demonstration projects' shortcomings by developing TRICARE. (GAO 1995)

## **B. TRICARE**

TRICARE itself is a combination of these different managed care projects. It was established by the Secretary of Defense under the authority of chapter 55 of Title 10, United States Code, principally, section 1097. The military health system's product is a benefits package modeled after the civilian sectors' managed care plans, preferred provider plans and fee-for-service plans. TRICARE is a regionally managed healthcare program for active duty and retired members of the uniformed services, their families and survivors. It brings together the healthcare resources of the Army, Air Force, and the Navy, and supplements them with networks of civilian healthcare professionals to provide access and quality services while maintaining the capability to support military operations. (OSD 1997)

TRICARE features a triple-option benefit, offering beneficiaries eligible for CHAMPUS two new options for health care in addition to the CHAMPUS program. The options vary in the choices beneficiaries have in selecting their physicians and the amount beneficiaries are required to contribute toward the portion of the cost of their care received from civilian providers. (OSD 1997)

### **1. TRICARE Prime**

The first new option, the TRICARE Prime option, is a HMO-like alternative that provides comprehensive medical care to beneficiaries through an integrated network of military and contracted civilian providers. Active duty members are automatically enrolled in this option and beneficiaries who select this option must enroll annually in the program, agreeing to go through an assigned military or civilian primary care physician for all of their care. The incentives for enrolling in Prime are: 1) no enrollment fees for active duty and their dependents, and low enrollment fees for all others, 2) low co-payments, 3) no annual deductible, and 4) no paperwork. Retirees, their dependents, and survivors age 65 and over are not eligible to enroll in Prime but remain eligible to receive care in military medical facilities. TRICARE prime is similar to health maintenance organization (HMO) programs offered by employers across the U.S. (OSD 1997)

### **2. TRICARE Standard**

TRICARE Standard is the current fee-for-service CHAMPUS program. This option provides beneficiaries the greatest freedom of choice in selecting civilian providers, but it also requires the highest beneficiary costs and is the most expensive way to receive healthcare in the MHS. Beneficiaries who use Standard must: 1) meet an annual deductible, 2) pay a co-payment of 20 percent for dependents of active duty and 25

percent for retirees, their dependents, and survivors of active duty members, and 3) be responsible for CHAMPUS claims in some cases. There is no requirement to enroll in the Standard option, and the patient may still seek care at a military hospital or clinic on a space-available basis. (OSD 1997)

### **3. TRICARE Extra**

TRICARE Extra is the second new option and lies between TRICARE Prime and Standard. It is a "preferred provider plan," through which beneficiaries receive a 5 percent discount on their co-payments if they use the civilian contracted network; however, they still must first pay their deductible. In most cases, healthcare will be more expensive than with TRICARE Prime and less expensive than Standard, but the beneficiary will still maintain a moderate degree of freedom of choice of provider. As with the Standard option, enrollment is not required. Patients in this option may seek care at a military hospital or clinic where space is available, but most of those appointments will be reserved for TRICARE Prime enrollees. (OSD 1997)

### **III. LITERATURE REVIEW**

Patient satisfaction means different things to different people. It is important to understand it in terms of behavioral models and to give it a working definition. In 1983 Gregory Pascoe from the University of California did an extensive literature review on the behavioral models of patient satisfaction in primary health care settings. The behavioral models provide insight into what things such as attitudes, expectations and beliefs, make up patient satisfaction, while a working definition provides a practical way to define it so it can be measured.

#### **A. BEHAVIORAL MODELS**

In the past, patient satisfaction has been the focus of three different theories summarized in the literature: expectancy-value theories, fulfillment theories and discrepancy theories. The expectancy-value model, developed by Linder-Pelz in 1982, proposed that attitudes that influence expectations are the primary indicators of patient satisfaction. Some examples are attitudes about the health care system in general, attitudes about the location of care received, and attitudes about the cost of treatment. An alternative theory is the fulfillment theory, which defines satisfaction as a function of the amount of care and attention received from a situation regardless of how much one feels they should receive or how much they would want to receive. The third model is the discrepancy theory, which includes the patient's perception of what is expected and valued, and which defines satisfaction by the difference between actual outcome and the patient's ideal of what the outcome should be. (Pascoe 1983)

Although each of these models describes patient satisfaction to some extent, each has some area of logical weakness. The expectancy-value model developed by Linder-Pelz is

closest to general acceptance. However, it is limited because although satisfaction in general has to do with expectations influenced by attitudes, satisfaction by actual services received could be influenced more by the patient's reaction to the actual experience than to their initial expectations. On the other hand, the fulfillment model assumes that objective outcomes alone will determine patient satisfaction and ignores the psychological aspects of defining care and services received. Lastly, the major disadvantage of the discrepancy theory model is that it does not take into account the reverse implication, which is the assumption that any difference between outcomes will result in dissatisfaction even if the actual outcome was better than the patient's original expectation of the outcome. It has been shown that each of these models that attempted to define patient satisfaction has some logical weakness and furthermore, none has been proven by empirical evidence. Because of these problems, researchers turned to consumer satisfaction models for insight in defining patient satisfaction. (Pascoe 1983)

Researchers have mostly agreed that consumer satisfaction is multidimensional, where overall satisfaction depends on the customer identifying important attributes of a product or service, and then determining if most of the attributes, or the most important attributes, are deemed favorable. The three major models used in customer satisfaction are the contrast model, the assimilation model and the assimilation-contrast model, all of which use the expectancy approach. The contrast model is based on the magnification of differences perceived between expectation and performance by the consumer, while the assimilation model goes one step further. In this second model, consumers will adjust their perceptions of performance to match their expectations by assimilating the difference, and lower their expectations. The hybrid of the above two models is the

assimilation-contrast model. With this model it is accepted that expectations are the customer's standard of judgement but there is some measurement of assimilation or latitude of acceptance if the customer's exact expectations are not met. All three of these models have been empirically tested and supported. (Pascoe 1983)

A combination of the patient satisfaction models and the consumer satisfaction models can be used to conceptualize what patient satisfaction is and what role it plays in healthcare. Psychological factors play a role in how patient satisfaction is defined. Pascoe defines patient satisfaction as "a healthcare recipient's reaction to salient aspects of the context, process, and result of [his or her] service experience" (1983). Patient satisfaction is then a comparison of a subjective standard to the actual healthcare experience of the service received. This may be based upon a subjective ideal, a sense of what is deserved, an average of past experience in other situations, or upon some learned, minimally acceptable level of service. (Pascoe 1983)

In understanding patient satisfaction the behavioral models give us insight into the human factors of attitude and expectations. However, patient satisfaction, in order to be measured, must be defined by a working definition. Research has shown that this can be done through defining patient satisfaction in terms of several factors.

## **B. A WORKING DEFINITION OF PATIENT SATISFACTION**

Throughout the literature, there are some common themes of factors that indicate patient satisfaction. These are accessibility, provider-patient interaction, clinical outcome, and choice of provider. (Pascoe 1983)

Access is one of the most important factors in determining patient satisfaction. It has many dimensions such as availability, accommodation, affordability, and acceptability

(Penchansky 1983). In Pascoe's review of recent studies, he found that all of the studies with one exception had shown a significant relationship between increased access and patient satisfaction (1983). Dissatisfaction was highly correlated with difficulty in scheduling appointments, length of waiting time between appointments, increased distance to travel to obtain care, and longer delays in obtaining services (Pascoe 1983).

The factor of provider-patient interaction has typically included technical competence, interpersonal skills of the provider and the length of time the visit lasts. The perception of a provider's competence is strongly interrelated with the provider's interpersonal skills and communication skills. High patient satisfaction has been indicated by a provider's ability to provide clear and adequate explanations, which in turn increase the patient's perception of the provider's technical competence. (Pascoe 1983)

A third factor, clinical outcome, has had mixed reviews on whether it is a valuable factor. Clinical outcomes are represented by a change in a patient's health status that is directly attributable to the treatment received. Most satisfaction surveys do not account for the patient's condition prior to treatment. In general, however, the severity of illness or health status of the patient will play a role in how the patient feels about the care he or she has received. A study by Stewart and Wanklin in 1978 found no relationship between outcomes and patient satisfaction, but other studies have found small to medium correlation with patient satisfaction. (Pascoe 1983)

The final factor is choice of provider. There has been significant evidence to indicate that the provider-patient fit is very important for a patient's overall satisfaction. For example, in a study cited in the journal *Hospitals*, Kaiser Permanente of Northern California surveyed 10,000 beneficiaries and found that choice in choosing one's own

primary care manager was the single most important predictor of overall satisfaction (Greene 1998). In a study by Ross in 1982, it was found that a patient was more likely to have increased satisfaction if the patient's and the physician's sociodemographics matched. Within this dimension of provider-patient fit is also continuity of care. Having a regular source of care and seeing the same provider are strongly related to high patient satisfaction (Pascoe 1983).

In addition to behaviors and the above-mentioned factors, two socio-demographic categories, sex and age, are often used in studies on patient satisfaction. In general, it was found from studies in the late 1970's that older patients tend to report higher levels of satisfaction than do younger patients and that women tend to be more satisfied than men (Pascoe 1983). However, there have been other studies from that same time period that have shown younger patients were more satisfied than older patients (Pascoe 1983). A survey conducted in 1989 at Brigham and Women's Hospital in Boston had mixed results on whether sex and age are significant in predicting patient satisfaction. Each of these variables may play a role in determining satisfaction. However, these could be somehow related to the organization, the severity of illness, or other factors (Pascoe 1983).

### **C. HEDIS**

Research seems to show patient satisfaction information does have an important role in evaluating primary health care. Because of its importance, the National Committee for Quality Assurance (NCQA), an organization whose goal is to report publicly on the quality of managed care plans, developed a system for standardizing the measurement of



salient aspects of quality care. This system is called the Health Plan Employer Data and Information Set (HEDIS).

HEDIS is a report card project that consists of a set of standardized performance measures developed by the Committee on Performance Measurement (CPM). The committee was made up of representatives of many different populations of constituents from both the public and the private healthcare sectors. These include representatives of Medicare, Medicaid, organized labor, medical providers, public health officials, health plan sponsors and lastly but of utmost importance, technical advisors who brought scientific rigor to the process of defining standard performance measures. The original purpose of HEDIS was to provide to purchasers and consumers of healthcare information based on outcomes to compare managed healthcare plans based on quality and not just cost. Eight performance measures were defined by the Committee on Performance Measures, one of which is "Member Satisfaction," the focus of this paper. The development of this report card and its performance measures by the CPM was very important in standardizing many of the healthcare industry's views, evaluations, and basic definitions. The million-dollar question has always been "what constitutes quality healthcare?" Through HEDIS and the efforts of the CPM, the establishment of these performance measures has addressed this question. Additionally, these measures have been further outlined by a set of defined categories as indicators. (HEDIS 1997)

The construct that is of prime importance to this paper is the definition of Patient Satisfaction as described in the "Member Satisfaction" measurement. This contains seven indicators of overall satisfaction which are: 1) Access: the ease in arranging for and getting care; 2) Communication: the level of explanation and attention given to the

patient; 3) Choice and Continuity: the ability of the patient to see the doctor of your choice; 4) Interpersonal care: the extent to which the medical staff takes a personal interest in the patient and his or her medical problems; 5) Quality and Outcomes: the overall quality of care, the outcomes of medical care, and how much the patient is helped; 6) Technical quality: the thoroughness of examinations and the accuracy of the diagnosis; and 7) Finances: the level of protection against hardship due to medical expenses and the extent of arrangements for getting help with financial problems. These seven categories have been defined as indicators of overall satisfaction by the Committee on Performance Measures and are used as a working definition for patient satisfaction. (NCQA 1997)



## **IV. METHODS**

### **A. 1996 DOD ANNUAL SURVEY FORM A**

The Department of Defense is required by Congress to conduct an annual survey of its active duty personnel, retirees, and eligible family members for the purpose of measuring accessibility, usage, and satisfaction in a range of health care services. The first of these surveys, referred to as the 1994-95 *Health Care Survey of DoD Beneficiaries* (HCSDB) was completed in the spring of 1995. This paper will analyze portions of Form A, the adult survey for 1996 HCSDB conducted by OASD(HA) Health Budgets and Programs. A point of contact may be reached at (202) 761-7895, Ext 246.

#### **1. Participants**

A sample of 156,838 beneficiaries was selected from a sampling frame of 6,455,915 adult sponsors and family members 18 years or older from the *Defense Enrollment Eligibility Reporting System* (DEERS) of eligible beneficiaries based on current eligibility information as of October 28, 1995. The sample was stratified into four beneficiary subgroups: 1) active duty personnel, 2) family members of active duty personnel, 3) retirees, their family members, and survivors under age 65, and 4) retirees, their family members, and survivors, age 65 and over. (WESTAT 1996)

#### **2. Materials**

The survey is a nine-part multi-faceted questionnaire that covers the eight performance measurements outlined by the HEDIS requirements. The survey consists of 84 questions covering the following sections: I) Your Health and Daily Activities; II) Preventive Health Care and Health Habits; III) Place of Medical Care and Health

Insurance Coverage; IV) Medical Care at Military Facilities; V) Medical Care at Civilian Facilities; VI) Dental Care; VII) TRICARE; VIII) Facts About You; and IX) Comments. This paper will primarily look at section IV, Medical Care at Military Facilities. Section IV consists of questions asking if the respondents had received any healthcare in the last 12 months from a Military Treatment Facility (MTF). If the answer was "yes" then they were asked about the following issues: 1) length of stay in the hospital; 2) number of outpatient visits; 3) number of calls to obtain an appointment; 4) length of waiting time in the doctor's office; 5) length of time to travel to the military or civilian facility; 6) waiting times between appointments and seeing the doctor based on acuity of care; 7) overall satisfaction; and 8) 32 aspects of satisfaction with the care the respondent received. (WESTAT 1996)

### **3. Procedures**

The survey mailing involved four waves of mailings to beneficiaries between April 15, 1996 and August 8, 1996. The multiple mailings were scheduled to maximize response rates for the data collection effort. First, an initial notification letter was mailed to the entire sample. Four weeks after the start date of the initial notification mailing, a first wave of surveys was mailed to the entire sample. Next, approximately two weeks after the first wave of survey mailings, a thank-you/reminder letter was mailed. Finally, four weeks after the mailing of the follow-up letters, a second wave mailing of surveys was directed to those who had failed to respond to previous mailings. The field was closed for targeted mailings on September 10, 1996. (WESTAT 1996)

In order to avoid data analysis errors, several types of records were removed from the 1996 HCSDB. These removals were performed when: 1) the same sample member

filled out more than one survey (if they received more than one mailing wave); 2) surveys were returned from sample members who were identified as deceased or incarcerated; 3) surveys were not filled out by the intended respondent; 4) surveys were blank and 5) there was a gender mismatch. If a sample member returned more than one survey, then the first wave survey was accepted and placed in the file. If the first wave survey was returned blank, then the second wave survey was selected. (WESTAT 1996)

A final step was taken to ensure that the person completing and returning the survey was the same person the survey was mailed to. A survey record was judged to be in error if the gender of the sample member was different than the self-reported gender. In these cases, it was evident that someone other than the intended sample member completed the survey. Overall, 1,329 records indicated that someone other than the sample member completed the survey were removed. (WESTAT 1996)

Of the 92,682 returned surveys, a total of 2,981 surveys were removed from the 1996 HCSDB data file, yielding 89,701 surveys. The overall response rate was 58.18%. The response rates for the subgroups were: 45.0% for active duty ; 45.9% for family members of active duty; 68.5% for retirees under 65; 80.5% for retirees age 65 and older; 57.5% for family members of retirees under 65 years; and 72.8% for family members of retirees 65 and older. (WESTAT 1996)

## **B. ANALYSIS**

The 1996 Annual Survey is a complex survey that uses techniques such as probability sampling, stratification, clustering and weighting. The purpose in analyzing the surveys is to identify and understand the causal mechanisms and to investigate the links between

overall patient satisfaction and the seven factors defined by the HEDIS report card along with demographic variables such as sex, age, and beneficiary group.

The first step in this analysis was to match the 34 questions from the patient satisfaction section of the Annual Survey to the NCQA questions found in the HEDIS Report card. Tables 1 shows the comparison of each of the DoD Annual survey questions with the report card questions.

Table 1. Comparison of Questions  
HEDIS Report Card Questions

1996 DoD Annual Survey Questions

<b>OVERALL</b> The overall health care provided through your health plan	<b>OVERALL Q47a</b> Q46a. I am satisfied with the health care that I received.
<b>ACCESS:Arranging for and Getting Care</b> a. Convenience of location of the doctor's office b. Hours when the doctor's office is open c. Access to specialty care if you need it d. Access to hospital care if you need it e. Access to medical care in an emergency f. Arrangements for making appointments for medical care by phone g. Length of time spent waiting at an office to see the doctor h. Length of time you wait between making an appointment for routine care and the day of your visit i. Availability of medical information or advice by phone j. Access to medical care whenever you need it k. Services available for getting prescriptions filled	<b>ACCESS:Arranging for and Getting Care Q47 a-ff</b> a. Convenience of location of treatment b. Convenience of hours d. Access to a specialist if you need it e. Access to hospital care if you need it f. Access to medical care in an emergency g. Ease of making appointments for health care by phone h. Length of time you wait at office to see the provider i. Length of time you wait between making an appointment for routine care and the day of your visit j. Availability of health care information or advice by phone c. Access to health care whenever you need it k. Services available for getting prescriptions filled
<b>TECHNICAL QUALITY</b> a. Thoroughness of examinations and accuracy of diagnoses b. Skill, experience, and training of doctors c. Thoroughness of treatment	<b>TECHNICAL QUALITY Q47l-o</b> l. Thoroughness of examination m. Ability to diagnose your health care problems n. Skill of health care providers o. Thoroughness of treatment
<b>QUALITY AND OUTCOMES</b> a. The outcomes of your medical care, how much you are helped b. Overall quality of care and service	<b>QUALITY AND OUTCOMES Q47p-q</b> p. The outcome of your health care (how much you are helped) q. Overall quality of health care
<b>COMMUNICATION</b> a. Explanations of medical procedures and tests b. Attention given to what you have to say c. Advice you get about ways to avoid illness and stay healthy	<b>COMMUNICATION Q47 r-u</b> r. Providers explanation of health care procedures s. Provider's explanation of medical tests t. Attention provider gives to what you have to say u. Advice provider gives you about ways to avoid illness and stay healthy

Table 1. Cont'd

HEDIS Report Card Questions	1996 DoD Annual Survey Questions
<b>INTERPERSONAL CARE</b> a. Friendliness and courtesy shown to you by doctors b. personal interest in you and your medical problems c. Respect shown to you, attention to your privacy d. Reassurance and support offered to you by doctors and staff e. Friendliness and courtesy shown to you by staff f. Amount of time you have with doctors and staff during a visit	<b>INTERPERSONAL CARE Q47v-aa&amp;dd</b> w. Courtesy shown to you by health care providers x. Provider's concern for you as a person dd. Health care providers personal interest in the outcome of your problem y. Provider's concern for your privacy z. Reassurance and support offered to you by health care providers v. Courtesy shown to you by administrative staff (e.g. receptionists) aa. Amount of time with health care providers during a visit
<b>CHOICE AND CONTINUITY</b> a. Number of doctors you have to choose from b. Arrangements for choosing a personal doctor c. Ease of seeing the doctor of your choice	<b>CHOICE AND CONTINUITY Q47bb-cc</b> bb. Ability to choose health care providers cc. Ease of seeing the provider of your choice
<b>FINANCES</b> a. Protection you have against hardship due to medical expenses b. Arrangements for you to get the medical care you need without financial problems	<b>FINANCES Q47ee-ff</b> ee. Protection you have against financial hardship due to medical expenses ff. Help with arrangements to get the health care you need without financial problems

### 1. Variable Selection

The survey data consisted of 89,701 observations and 402 variables that included all of the survey questions responses and the constructed and scaled variables that were developed by the contractor, WESTAT, to support analysis of the data. Section IV of the questionnaire deals with beneficiaries' satisfaction with health care they received at the military facilities. The satisfaction variables used in the analysis from the questionnaire are from questions 46a and 47a-ff pertaining to the military. The response for question 46a, concerning overall satisfaction, had a Likert scale with responses of: strongly agree, agree, neither agree nor disagree, disagree, and strongly disagree. These were assigned values in order from 5 to 1. The remaining questions (Q47a-ff) had a Likert scale with responses of: excellent, very good, good, fair, poor and not applicable. The individual responses for each of these questions were given a score from 5 down to 1 plus NA. Then the set of questions within



each of the seven HEDIS factors was averaged to obtain one value for each variable that described the essence of the outcome being measured. So, for example, the responses for the four questions concerning technical quality were converted to numbers on the 1-5 scale; then the average of those four numbers was used as the number for *technical* for that particular respondent. This type of manipulation of the data is acceptable as long as the original scales from excellent to poor are not referred to in the resulting conclusions (Agresti 1984).

## **2. XPASTUSE**

From Section IV, a variable called *XPASTUSE* was constructed by the contractor, WESTAT, INC., to represent whether a beneficiary had used any military care (question 38) within the past 12 months. The *XPASTUSE* variable has 4 levels of use: 1=military only, 2=civilian only, 3=both military and civilian and “.”=NA, no use of any medical facility within the past 12 months. All records with *XPASTUSE*=1 (military only) were extracted for use in the data analysis.

## **3. Dependent And Independent Variable Selection**

The dependent variable *overall* was the response variable from question 46a, “I am satisfied with the health care that I received.” In order to use logistic regression and to obtain a clear distinction between dissatisfaction and satisfaction, *overall* was converted to a dichotomous variable with 0=dissatisfied and 1=satisfied. Every value that was less than 3 was set equal to 0 to represent dissatisfaction, and every value that was greater than or equal to 3 was set to 1 to represent satisfaction. For the trellis graphic display, the response variable used the original 5 factor levels of question 46a. The independent explanatory variables were the seven HEDIS averages *access*, *technical*, *quality*, *communication*,

*interpersonal, choice, and finances* and three demographic variables *age, sex* and *beneficiary group*.

### C. LOGISTIC REGRESSION

The responses of survey questions are considered to be ordinal categorical data where there is a clear ordering of categories, but the absolute distances among them are unknown (Agresti 1984). However, ordinal responses are quantitative in the sense that each level on its scale can be compared in terms of whether it corresponds to a greater or smaller magnitude of each characteristic (Agresti 1984). Alan Agresti, in his book *Analysis of Ordinal Categorical Data* states that "The distinction regarding whether data are continuous or discrete is often less important than whether the data are qualitative (nominal) or quantitative (ordinal or interval)" (1984). Since this complex survey uses ordinal Likert scales for measurement of questions, logistic regression is an appropriate tool for data when a response variable exists as a binary categorical variable, and the explanatory variables are a mix of categorical and quantitative (Agresti 1984).

#### 1. Data Subsets for Analysis

Three approaches were taken to using logistic regression in analyzing this complex survey. The first approach took a random sample from the large data set to look at a global view of patient satisfaction attitudes. One of the limitations of many statistical programs is their lack of ability to handle missing data. A large portion of respondents utilized the NA option on some of the questions 47 a-ff, and SPLUS 4.5, the data analysis software, omits in logistic regression all observations with any NAs. Next, a large random sample of 25,000 observations was taken from the total of 89,701 observations without replacement to form the first tier of the data set. The data were then divided by the *XPASTUSE* variable into

three groups according to whether they had used medical treatment facilities in a military institution, or a civilian institution, or both. Logistic regression was used on the data set where beneficiaries had only used military healthcare.

The second approach was to first sort the entire data sample by the *XPASTUSE* variable and extract all of the beneficiaries who had used military healthcare in the past year. The data were then sorted by region to look and see if there were any regional effects of patient satisfaction among beneficiary groups. Region 2, the Mid-Atlantic, was selected from the regions to be used as a representative in the analysis. Logistic regression was then used on the complete subset of beneficiaries who had used only military healthcare in Region 2.

The third approach was to break the data sets down even further within Region 2, by beneficiary group, to determine if there were any differences among the variables for patients who have used only military healthcare.

## **2. Procedures**

For each of the three approaches, a data frame was constructed with *overall* as the response variable, and as the explanatory variables, the seven HEDIS variables and the appropriate demographic variables. In addition to the dependent and the independent variables, a column of weights developed by the contractor, WESTAT, INC., was used in the analysis to account for the practical limitations of the survey such as imprecise survey frames and non-response by beneficiaries. In the initial models the response variable was modeled by the explanatory variables appearing only as the main effects. Then each of these was used in a stepwise selection process that permitted the addition of second order interactions.

## **D. TRELLIS GRAPHICS**

### **1. Explanation of Method**

Visualization of data sets is one of the most important techniques in statistical analysis. The Trellis Graphics Display framework, a recently-developed method for visualizing data, is based on a system of panels that look like a garden trellis (Becker 1998). While graphical visualization techniques have been available at least since the 1930s, the idea of Trellis arose from the need to study data structures with complex dependencies and interactions among the explanatory variables acting upon the response (Becker 1998). Trellising was first described in William S. Cleveland's book *Visualizing Data*, written in 1993, which used multi-panel conditioning for up to two conditioning variables (Becker 1998). Univariate, bivariate, and trivariate data can all be visualized in relation to a physical reality of space. But for any data set that has four or more dimensions, called a hypervariate data set, there is no way to visualize all of the variables together in the physical space (Cleveland 1993). Cleveland found that the solution to visualizing hypervariate data is to visualize it cognitively, not perceptually, through looking into the subspaces of the data (Cleveland 1993). Since most common graphical approaches for visualizing data could only handle two explanatory variables, the need for visualization of three or more explanatory variables required the development of new graphical technology (Becker 1996).

From 1993 to 1996 William Cleveland and Richard Becker developed and designed a visualization graphics method that has been implemented in the S-PLUS graphics to view many variables on a multi-panel display. The display panels are laid out into rows, columns and pages on which subsets of data are graphed and displayed using well-known graphical tools such as scatterplots, boxplots, normal quantile plots, and 3-D plots. Each panel shows

the relationship of a response variable to one or two independent variables, conditional on the values of some additional independent variables. (Becker 1996)

The Trellis Display is a three-way rectangular array of panels with columns, rows, and pages that are read starting at the bottom of the page and going from left to right and then up the page, like a graph. Figure 1 below is a series of boxplots that has a response, explanatory and conditioning variables.

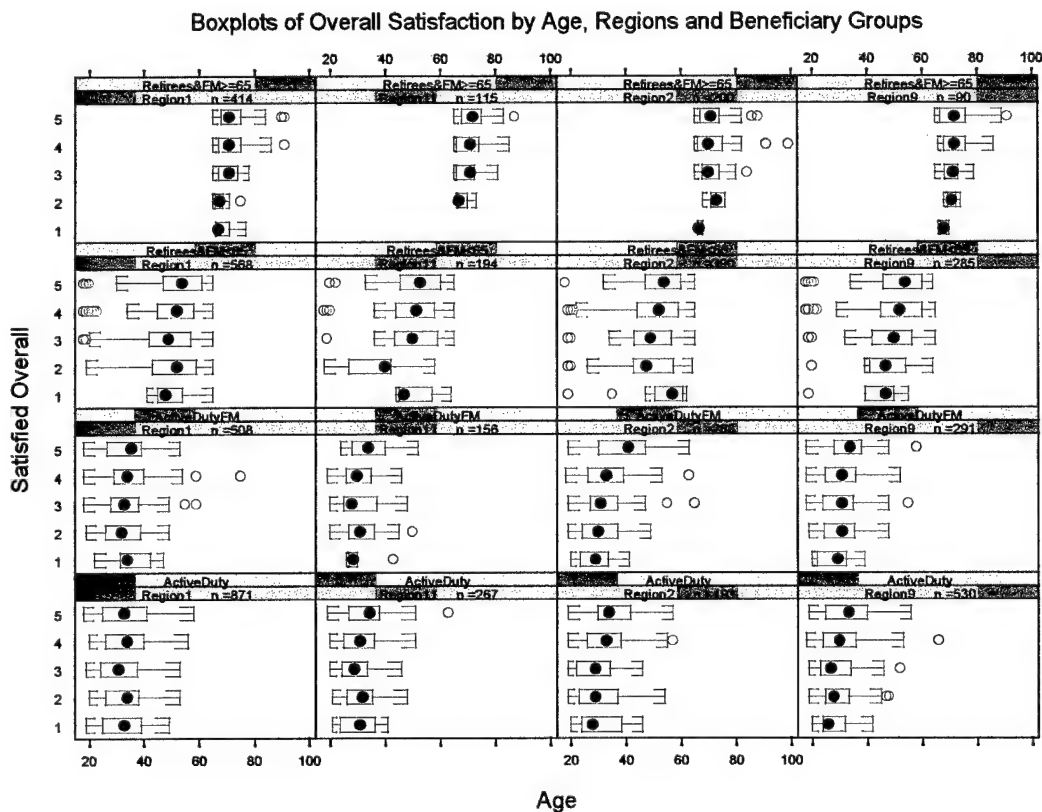


Figure 1. Overall Satisfaction Modeled by Age.

The y variable is the response variable graphed on the y-axis of each panel, and the x variable is one of the explanatory variables, graphed on the x-axis. In this example, y is

*overall satisfied* and  $x$  is *age*. The conditioning variables, which are *region* and *beneficiary group*, are the other explanatory variables that are being held constant at a particular set of factor levels or for continuous-data, in a defined interval. The names of the conditioning variables are given in a strip label at the top of each panel. Here, the first conditioning variable is *region* and the second is *beneficiary group*. Each of these labels has a dark shaded bar in the same color as the strip label of the panel that indicates the value of the variable that is being held constant. The strip label and the bar show how the values of the conditioning explanatory variables are changing as they go throughout the trellis. The colors used in the assembly of the panels are analogous colors that aid in the decoding of the picture. Insight and understanding of the data structure is found by examining the relationships between the response and the conditioning variables. (Becker 1996)

There are four key elements which make the Trellis Graphics Display different from other graphics methods. The first is the "Main-Effects Ordering." This display method allows the ordering of the response variable by median, mean, or any special ordering that may be naturally occurring in the data. At the same time, the conditioning variables may also be ordered to obtain a natural flow of data that can easily be visualized. Figure 2 shows a graph of Region 2 with the HEDIS variables and beneficiary groups in alphabetical order. (Becker 1996)

It is difficult to read this graph quickly and to recognize the variables which are rated highest and lowest and the variables for which the sexes differ.

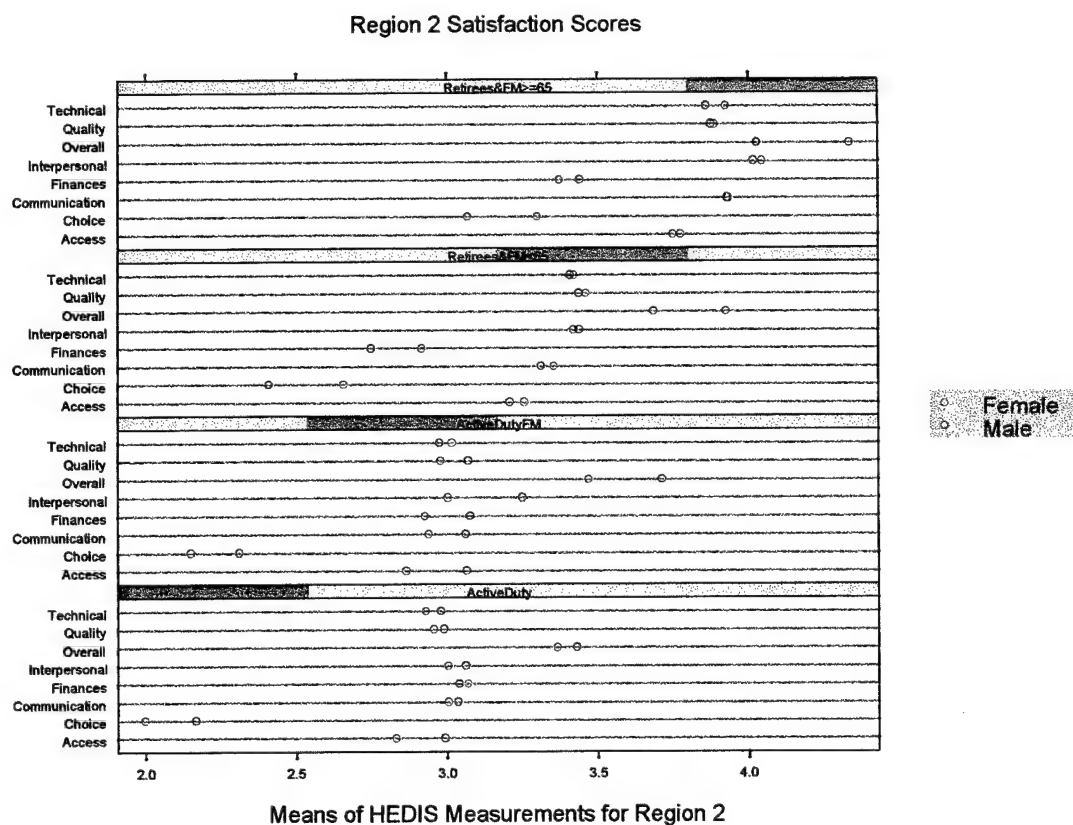


Figure 2 Alphabetized Factors.

Figure 3 shows how the main effects ordering property makes the visualization of the data much easier to read and to quickly see the differences between the variables. In this figure, the HEDIS variables and the beneficiary groups are reordered from lowest median to highest median. It is now much clearer that active duty beneficiaries have a lower median overall than the other groups and the HEDIS variable *choice* has been rated distinctly lower for all beneficiary groups and *overall* has been rated distinctly higher by each beneficiary group.

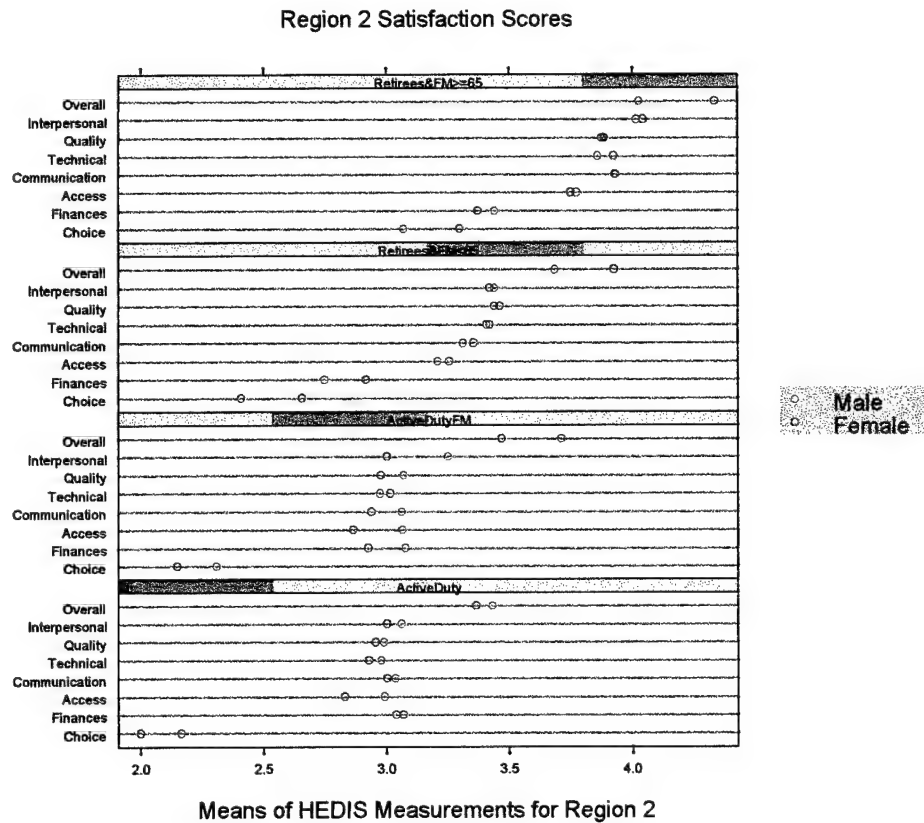


Figure 3 Main-effects Ordering by Median.

The second element that distinguishes Trellis from other graphics methods is the control of the “aspect ratio.” The aspect ratio the height/width ratio of the data rectangle, that is the panel rectangle that encloses all of the data. Graphical theory has shown that the banking of  $45^\circ$  gives the best perception of relative slopes and curvatures of a line (Becker 1996). Because this is an important part of graphing, the Trellising system gives the users direct access to define the aspect ratio. Figure 3 is the same picture as Figure 2, but banked by  $45^\circ$ .

The third element that makes this method extremely valuable is the ability to condition on more than two variables. The ability to arrange the variables allows control of the explanatory variables while viewing multiple comparisons of many combinations of



variables. Figure 4 shows the histograms of “age” while the regions move from left to right and the beneficiary groups move from bottom to top. This ability to condition on more than two variables allows further investigations of many different demographic subsets.

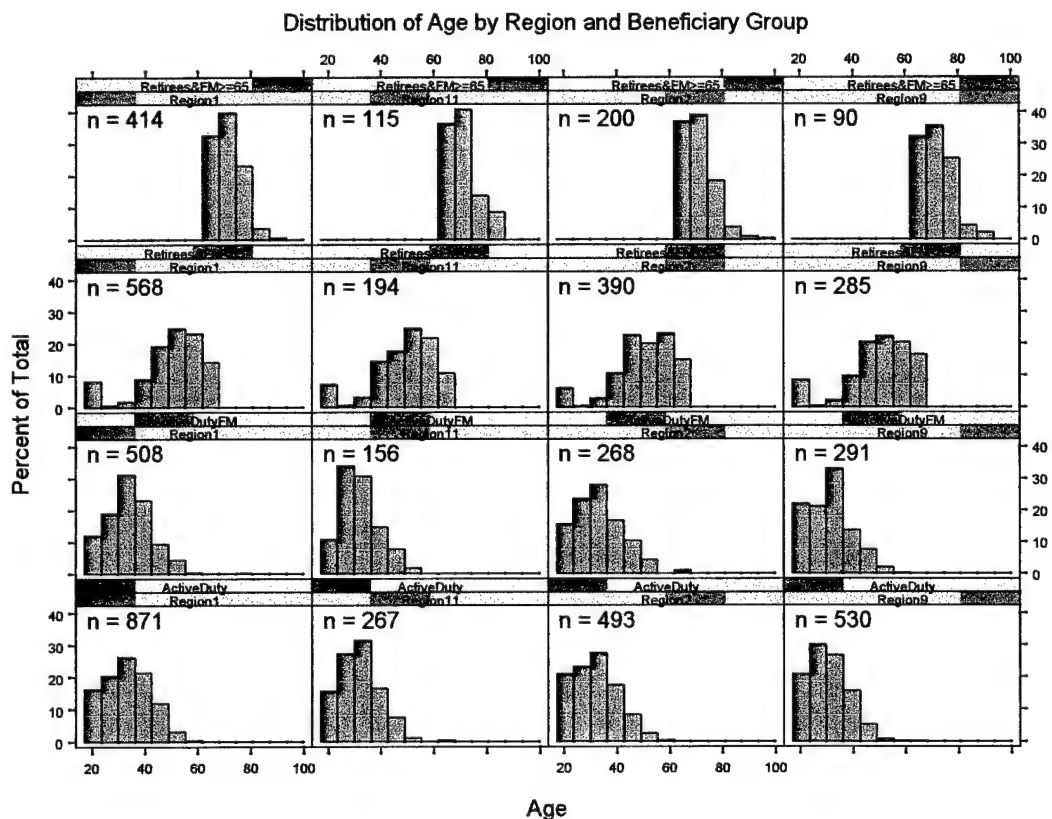


Figure 4. Conditional Variables.

Lastly, the Trellis software allows for conditioning variables to be continuous. It has a function called *shingle()* that allows the user to divide a variable into overlapping intervals, each with the same number of points, to use continuous variables as conditional variables (Becker 1996). This is extremely important for uncovering interactions between explanatory variables since it allows the conditioning variable to be held nearly constant.

## **2. Data Subset**

Regions 1, 2, 9, and 11 were selected from the fourteen regions based on their location. These included the three Naval teaching hospitals, The National Naval Medical Center in Bethesda MD, Naval Hospital Portsmouth in VA, Naval Hospital San Diego in CA, and a Fleet Hospital, Naval Hospital Bremerton in WA. These regions were selected to use in studying the interactions among variables and for showing the HEDIS variables that may help military medical facilities provide better care for their patients.

## **3. Procedures**

In order to visualize the relationships among variables in the four regions these steps were taken. The first step was to see an overall view of what the data looked like. To do this, the histogram was first used to display the densities of the different ages among beneficiary groups and sex. This is important to see because age was not used as a conditioning variable since beneficiary groups provide decision makers with a better demographic breakdown based on the levels of access outlined in Title 10, U.S.C. Chapter 55, Sections 1071-1106 which describes the entitlement programs. Next, the satisfaction scores for the four regions were shown to determine if there are any areas among the HEDIS factors that the primary military facilities in each region can use to provide better care within each subset of beneficiaries. This was done by calculating the means of each HEDIS factor or each conditioning variable and plotting them together to show comparisons and to see an overview of the data for each of the four regions.

The last approach investigated the complex interactions and dependencies among the HEDIS variables and the demographic variables. Trellis was used to model four variables at a time and then used to investigate even more complex interactions with five variables.

This step used boxplots to summarize the conditional distributions. In a boxplot, the dot represents the center of the data or the median of the distribution. The upper and lower ends of the box represent the 25<sup>th</sup> and 75<sup>th</sup> percentiles and therefore the distance between the ends of the box indicates how tightly packed the values are around the median (Cleveland 1993).

## V. RESULTS

### A. LOGISTIC REGRESSION

The first approach outlining the methods was to take a random sample of 25,000 from the data set of 89,701 responses. After subsetting the data for military use only and accounting for missing data, the model used a sample size of N=4,361 with 27 explanatory variables. The initial main-effects generalized linear model that included regions showed all of the variables, except the dummy variables for regions 6 and 12 to be significant. Table 2 shows the results of this approach.

Table 2 Logistic Regression of Main-effects Model with Regions.

	Coefficient Value	Std. Error	t value
(Intercept)	-4.088	0.034	-117.206
access	0.628	0.009	64.550
technical	0.196	0.011	8.477
quality	0.800	0.011	71.953
communication	-0.145	0.010	-13.879
interpersonal	0.340	0.010	32.394
choice	0.321	0.007	45.566
finances	-0.147	0.005	-28.116
Ben.Group2	0.332	0.015	21.531
Ben.Group3	0.434	0.019	22.165
Ben.Group4	1.099	0.059	18.328
Age	0.009	0.000	14.650
REGION2	-0.619	0.019	-31.759
REGION3	0.264	0.021	12.511
REGION4	0.210	0.026	7.883
REGION5	0.326	0.024	13.042
REGION6	-0.014	0.019	-0.732
REGION7	0.068	0.026	2.543
REGION8	0.310	0.022	13.754
REGION9	0.757	0.023	32.362
REGION10	0.398	0.036	10.999
REGION11	0.407	0.033	12.130
REGION12	-0.043	0.035	-1.223
REGION13	0.186	0.048	3.830
REGION14	0.136	0.019	6.927
sex	-0.234	0.012	-18.079

One of the troubling results found in the main-effects model and found in the 2<sup>nd</sup> order interaction model was a negative sign for the coefficients of variables such as

*communication*, and *finances*. The negative correlation implies that the patients who rated *overall satisfied* high, were less satisfied than those who rated *overall satisfied* low for those variables. Similar counter-intuitive results were also found in the 2<sup>nd</sup> order interaction models.

The above models were very complex and too large to explain with clarity. The data was broken down further into regions because of the scores of interactions. Region 2 with a sample size of 1351 was selected for this analysis. The results for the main-effects model and the 2<sup>nd</sup> order interaction model were similar, showing negative values for the coefficients of the main variables such as *finances*, *communication* and *interpersonal*.

As a final step, the data was broken down by beneficiary group to see if there were any differences among the types of beneficiaries that would lead to interactions and negative coefficients. Region 2 was divided into beneficiary groups with the following N: active duty N=493, active duty family members N=268, retirees and their family members <65 years old, N=390, and retirees and their family members ≥ 65 years old, N=200. The results, using stepwise regression, from the main-effects model by beneficiary group showed variations between each group. In Table 3, the active duty group added *technical* as a negative coefficient but still had all of the variables as significant.

Table 3 Active Duty main-effects model.

Coefficient	Value	Std. Error	t value
(Intercept)	-8.023	0.067	-119.455
technical	-0.651	0.020	-31.487
access	0.687	0.016	41.227
finances	0.419	0.009	-42.137
choice	0.654	0.013	48.826
interpersonal	0.407	0.018	21.984
communication	-0.312	0.019	-15.868
quality	2.768	0.023	115.819
sex	0.364	0.027	13.288
age	0.031	0.001	26.781

In Table 4, the active duty family member group found *finances* and *access* to be insignificant.

Table 4 Active Duty Family Members main-effects model

Coefficient	Value	Std. Error	t value
(Intercept)	-4.974	0.091	-54.264
technical	0.439	0.036	12.063
access	-0.009	0.029	-0.316
finances	0.003	0.014	0.270
choice	0.637	0.020	31.438
interpersonal	1.036	0.035	29.014
communication	-0.689	0.027	-24.811
quality	1.357	0.035	38.751
sex	-0.723	0.046	-15.682
age	-0.013	0.001	-7.774

In Table 5, the model of the retirees and their family members who are younger than age 65 showed all of the variables to have significance except *interpersonal* and did not have any negative correlation for the variables that were significant.

Table 5 Retirees and Family Members <65 main-effects model

Coefficient	Value	Std. Error	t value
(Intercept)	-8.001	0.154	-51.927
technical	0.989	0.052	19.019
access	0.756	0.043	17.527
finances	0.129	0.024	5.300
choice	0.475	0.033	14.283
interpersonal	-0.019	0.046	-0.421
communication	0.011	0.048	8.431
quality	0.564	0.046	12.260
sex	0.450	0.045	9.957
age	0.016	0.001	8.847

And lastly, Table 6 gives the main-effects model for the retirees and their family members who are age 65 years and older. It showed *technical* and *access* as non-significant and had negative correlation for *finances*, *choice*, and *communication* with the response variable *overall*.

**Table 6 Retirees and Family Members  $\geq 65$  main-effects model**

Coefficient	Value	Std. Error	t value
(Intercept)	-15.982	1.627	-9.820
technical	0.193	0.214	0.901
access	0.103	0.182	0.568
finances	-0.275	0.115	-2.382
choice	-0.496	0.268	-2.356
interpersonal	3.439	0.337	10.198
communication	-0.918	0.285	-3.218
quality	2.245	0.315	7.116
sex	5.242	0.411	12.749
age	0.048	0.021	2.321

The 2<sup>nd</sup> order models by beneficiary groups were similar to the first two approaches with many combinations of significant interactions between explanatory variables.

The three approaches above used logistic regression to predict overall patient satisfaction by the seven HEDIS variables and the demographic variables. Each primarily showed that almost all of the variables are important with some variables such as *finance* and *communication* had some negative correlation with the response variable *overall*. In addition, there were complicated interactions in each the data sets among the demographic variables and the HEDIS measurements. One of the Trellis Graphics display method's strength is its ability to uncover interactions through visualization and conditioning of variables.

## **B. TRELIS GRAPHICS**

### **1. Age Distributions of Regions 1, 2, 9, and 11**

One of the beneficial features of Trellis is the ability to view distributions of subgroups at a glance. The analysis of the patient satisfaction data set used the subgroups *region*, *beneficiary group* and *sex*. Although age was one of the initial demographic variables, by definition, the beneficiary group delineation provided an idea of the range of ages as shown in Figure 5 for female respondents and Figure 6 for male respondents.

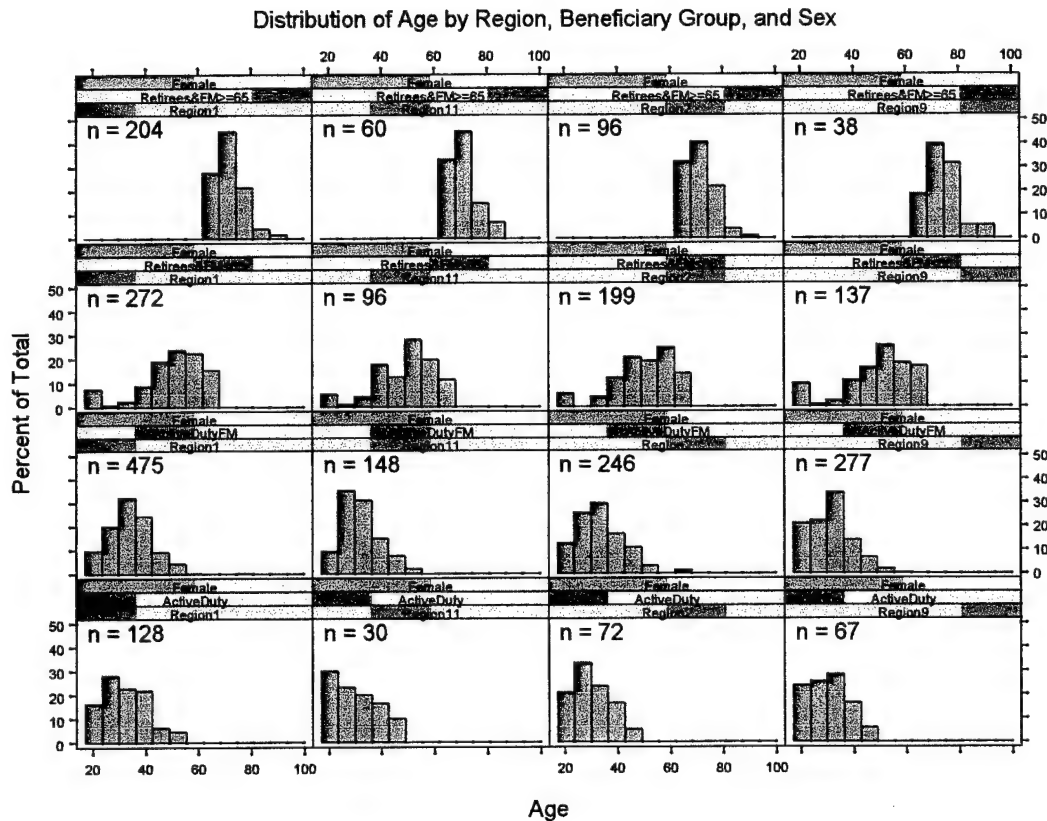


Figure 5. Histogram of Female ages by Beneficiary Group.

In row 1 of Figure 5 there is only a small number of female active duty respondents in each region. Figure 6 shows a comparison of the distribution of ages of the male respondents for the given regions. Active duty males had the largest population of respondents in each of the regions; in each case the smallest group was male family members of active duty personnel. The two retiree groups had approximately the same distribution for both males and females with the ages of the younger population mostly falling within the 40-60 year old range and the age of the older group falling within the 60-80 year old range.



The number of returned surveys within the four regions are different with Region 1, the Northeast, which includes the National Capital area, being the largest. Region 11, the Northwest, has the smallest response rate and Region 2, the Mid-Atlantic, or Portsmouth, VA area and Region 9, Southern California, or San Diego area having about the same distribution of sizes.

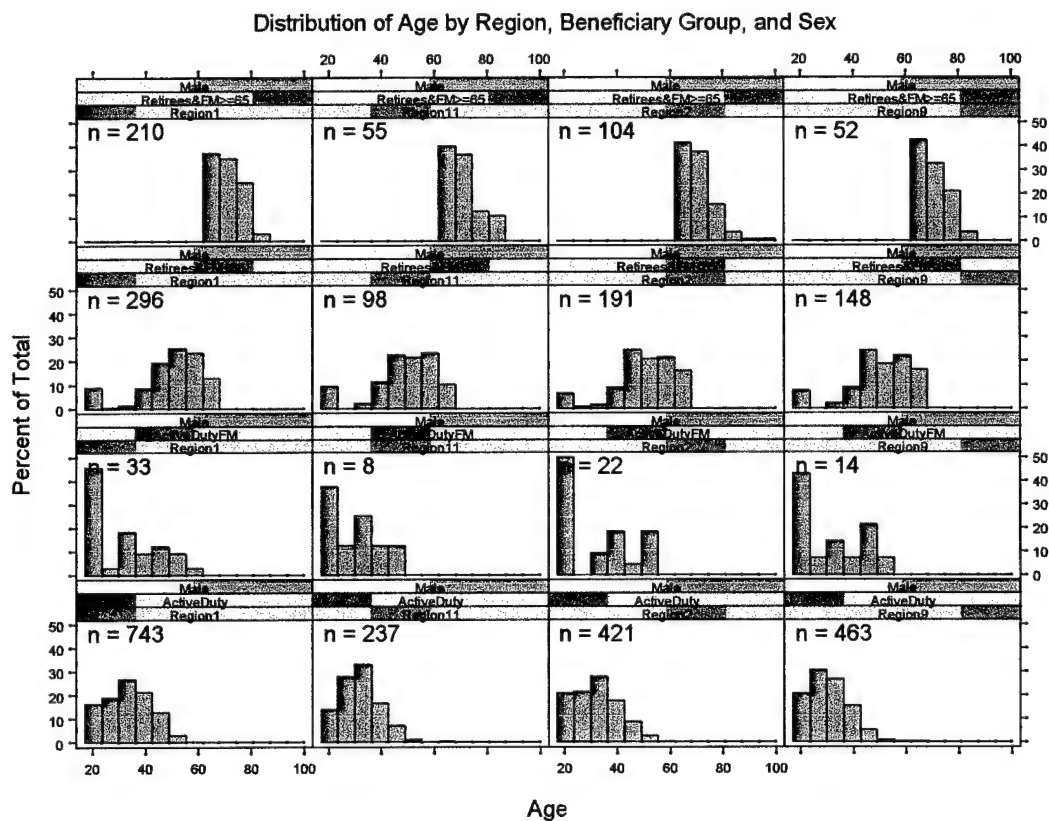


Figure 6 Histogram of Male Ages by Beneficiary Group.

## 2. Dotplots of HEDIS Measurements

In order to help military medical facilities locate key issues to improve healthcare for their patients, the different scores for the HEDIS measurements should be analyzed for each region. The dotplot of the mean scores is one of the best techniques for providing a

highly accurate visual decoding of data (Becker 1996). First, the mean for each of the HEDIS variables was calculated by *region*, *beneficiary group*, and *sex*. Then Trellis graphics was used to plot the means of each measurement by HEDIS variable, *region*, and *sex* in an easy-to-read picture. Figure 7 below shows all four regions ordered by their overall medians.

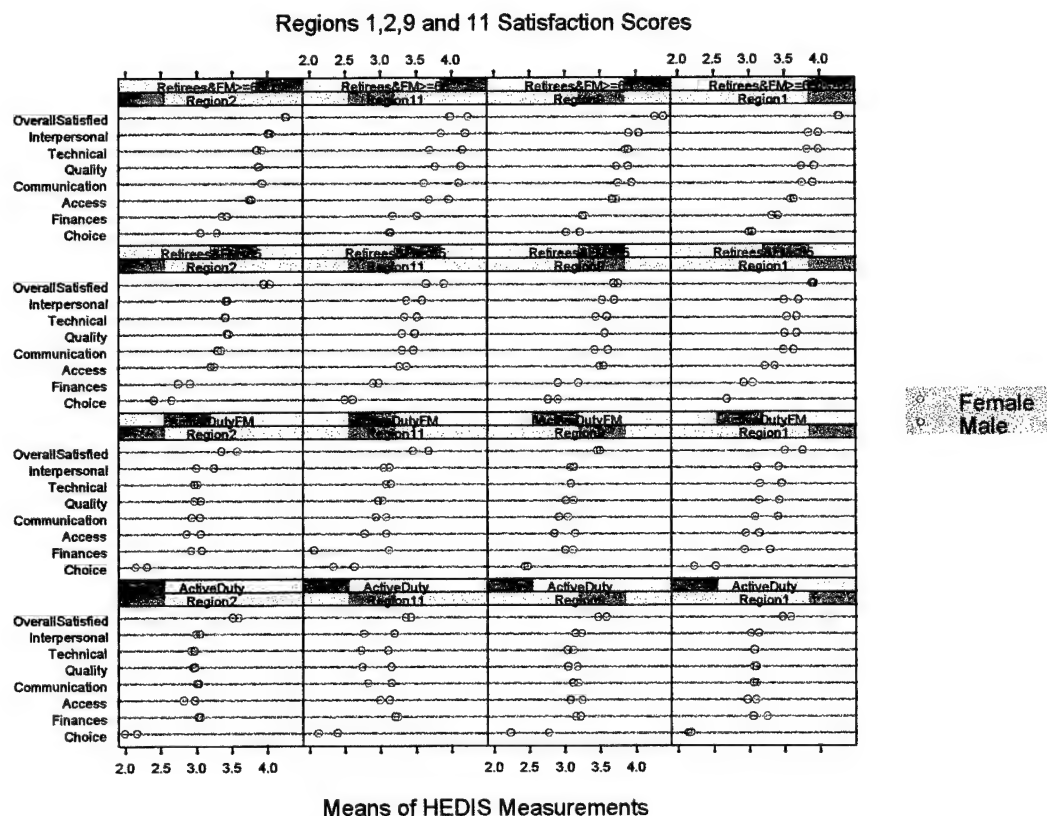


Figure 7 Regions 1, 2, 9, and 11.

The *choice* variable has the lowest median overall, and the variable *overall* has the highest median. Panel (1,1) in the lower left corner shows that Region 2 has the lowest median and in panel (4,4), retirees and their family members over 65 years old has the highest median.

The variable *choice* was rated the lowest by each beneficiary group in each of the four regions with the exception of male active duty family members rating *finance* lower in Region 11. It is also interesting to note that the women in Regions 11 and 1 are very different from the men. There seems to be an upward trend from active duty beneficiaries to retirees, indicating that the older population tends to be happier than the younger groups. These relationships will be examined in greater detail as each of the four regions is discussed individually.

Grouping the regions together on one graph provides a comparison between regions. However, it is best to graph them separately; that way the greater spread of the values can better show distinguishing features of the satisfaction scores. Region 2's satisfaction scores are shown in Figure 8.

The variable *choice* here is shown on a finer scale than in Figure 7 and demonstrates the difference of ratings by the different beneficiary groups. For active duty members (females: N=72, males: N=421) and their families (females: N=246, males: N=22), women gave *choice* a lower score than the men. In addition, for all other factors except *finances* for the active duty members and *technical* for the family members, the women gave lower ratings than the men. For retirees and their family members under 65 (females: N=199, males: N=191), there was no distinct separation between the sexes. *Finances* have the second-lowest ratings for the retiree groups. Overall, the older beneficiaries seemed to be happier with military facilities than active duty members and their families.

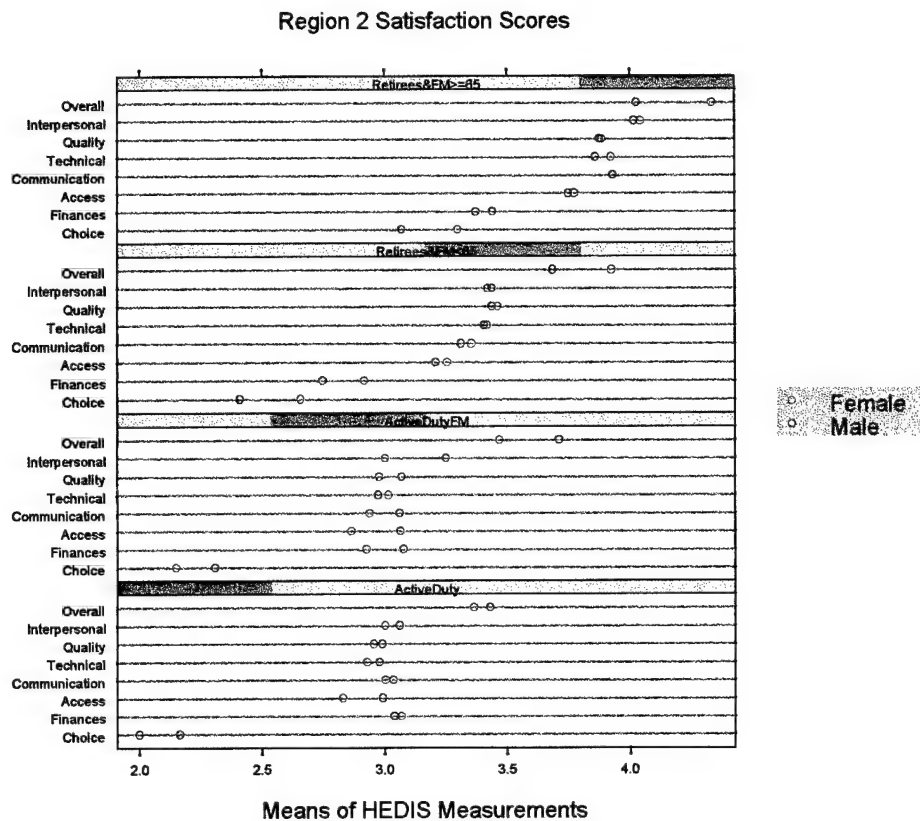


Figure 8 Region 2.

Region 11, shown in Figure 9, had the second lowest overall median score. Region 11 was very different from the other regions primarily in that there is a clear distinction between men and women for their satisfaction scores. There was almost a full point difference between males and females in almost every category for each beneficiary group. The most striking difference was for active duty family members who rated the factor *finances*. However, on closer examination, the small number of respondents in the male family member group (N=8) may somewhat overstate the difference compared to the larger

group of females (N=148).

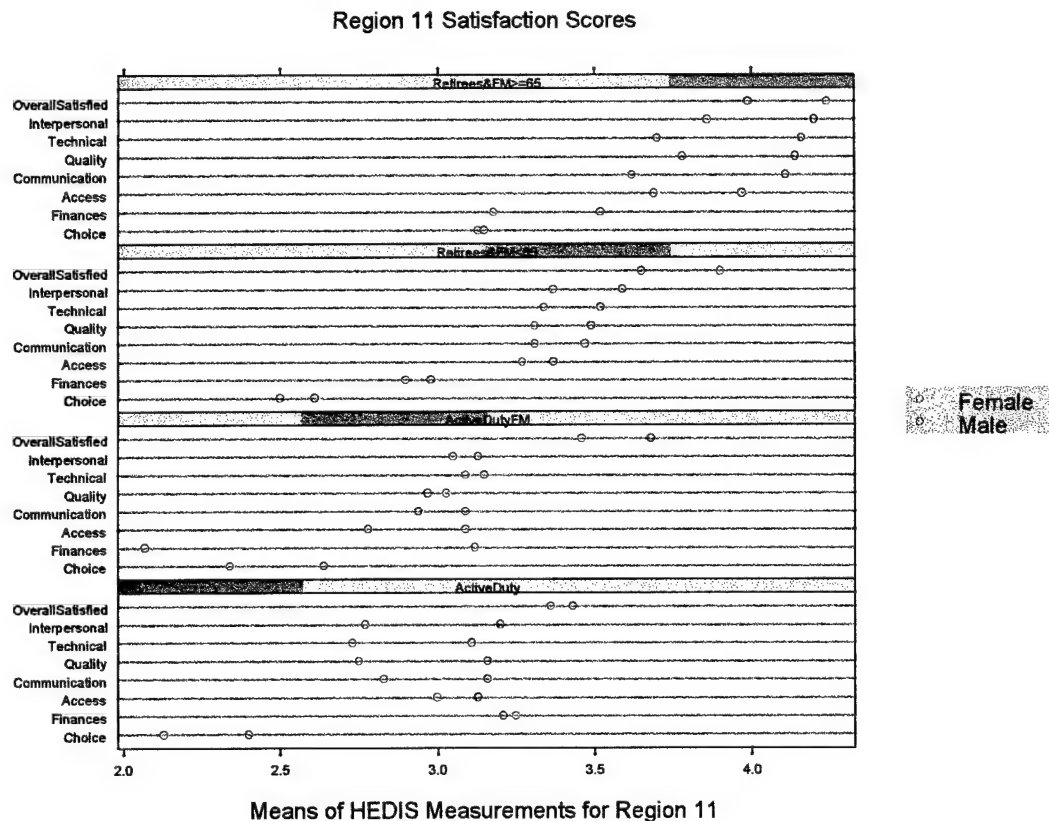


Figure 9 Region 11.

The *overall* satisfaction score for the retirees and their family members age 65 years and older was a deviation for men (N=55) from the dominant trend. In this group, *overall* is rated lower than the next four highest factors, *interpersonal*, *technical*, *quality*, *communication*, and *access*. If *overall* is thought to be approximately an average of the other variables, then this was the only group that indicated that result. With the exception of this one value, the spread from the beneficiaries' ratings from all other variables to *overall* was very large which is somewhat an anomaly. The last noteworthy finding is that given the low number of active duty family members who are male, females across all of the

beneficiary groups in Region 11 were almost always less happy than males. This was shown for every HEDIS measurement except *finance* for the active duty groups and for *overall satisfied* for retirees and family members younger than age 65.

Region 9 had the second highest median score of the four regions as shown in Figure 10. There are two strikingly different findings for Region 9 that were distinct from those in the other regions. First, as shown by the ordering of the colors in the key, males had the lower median response rate. In all of the other regions, females had the lower median.

The second finding is that Region 9 was the only region where active duty males (N=463) rated *choice* lower than females (N=67); here the difference in the spread of ratings is approximately a full point. This region was also the only one in which the active duty men were predominantly less happy than the women. This is also seen for the active duty family members who are male: though there are only 14 men in this group; when put with the 463 active duty males who felt similarly, this is a substantial finding.

Additionally, the *overall* marks were also very high in this region which was not what would be expected with such a score. It is also interesting to note that even though the males in the two active duty groups were less happy in almost all of the HEDIS measurements, they still rated *overall* (satisfied) higher than the females in Region 9.

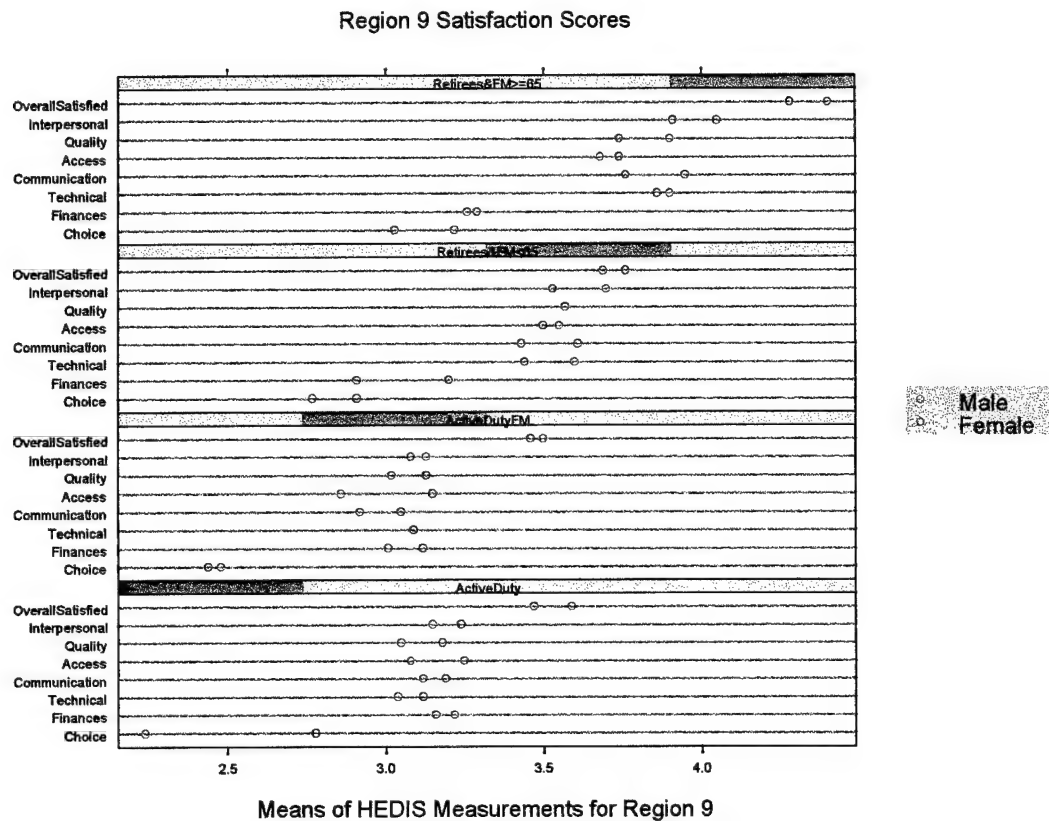


Figure 10 Region 9.

The National Capitol Region had the highest median among the four regions. Figure 11 shows the satisfaction scores for Region 1. Within this region the variables *choice* and *overall* stand out and follow a trend similar to that in the other regions. However, the spread from active duty members (female: N=128, male: N=743) to retirees and their family members age 65 and older (females: N=204, males: N=210) for *choice* is very wide. For retirees and their family members younger than age 65, the males (N=296) were more unhappy than the females (N=272) for the measurements *finance* and *choice*. Also the spread between the sexes in all of the beneficiary groups except active duty members is very

noticeable indicating different attitudes and feelings among men and women respondents in Region 1.

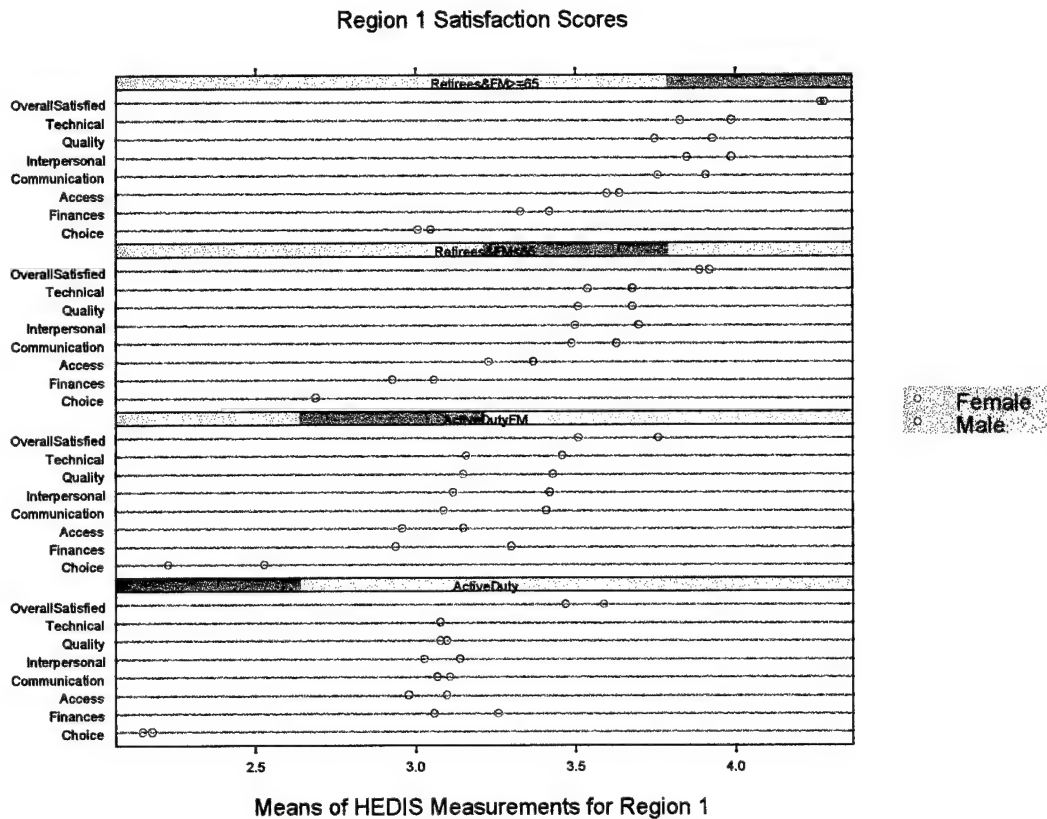


Figure 11 Region 1.

### 3. Trellis Interactions

Interactions among variables of a multivariate data set occur when there is interdependence among variables at different levels or when the effect of a variable depends on the values of the other explanatory variables. The logistic regression models all showed complex interactions occurring among the HEDIS variables, between the HEDIS variables and the demographic variables, and between the demographic variables *region*, *sex* and



*beneficiary groups*. Interactions can cause difficulties in using logistic regression to predict a response variable when they are too numerous to explain causality clearly and concisely. If a data set has explanatory variables that have strong dependencies among themselves, like the HEDIS measurements, which are attitudes of respondents, then interactions among variables are likely and can be difficult to identify. The Trellis Graphics framework is extremely helpful in seeing interactions and viewing complex data sets.

Figure 12 is a graph with boxplots of *overall satisfaction* modeled by *access* while holding each region and beneficiary group as conditional constants.

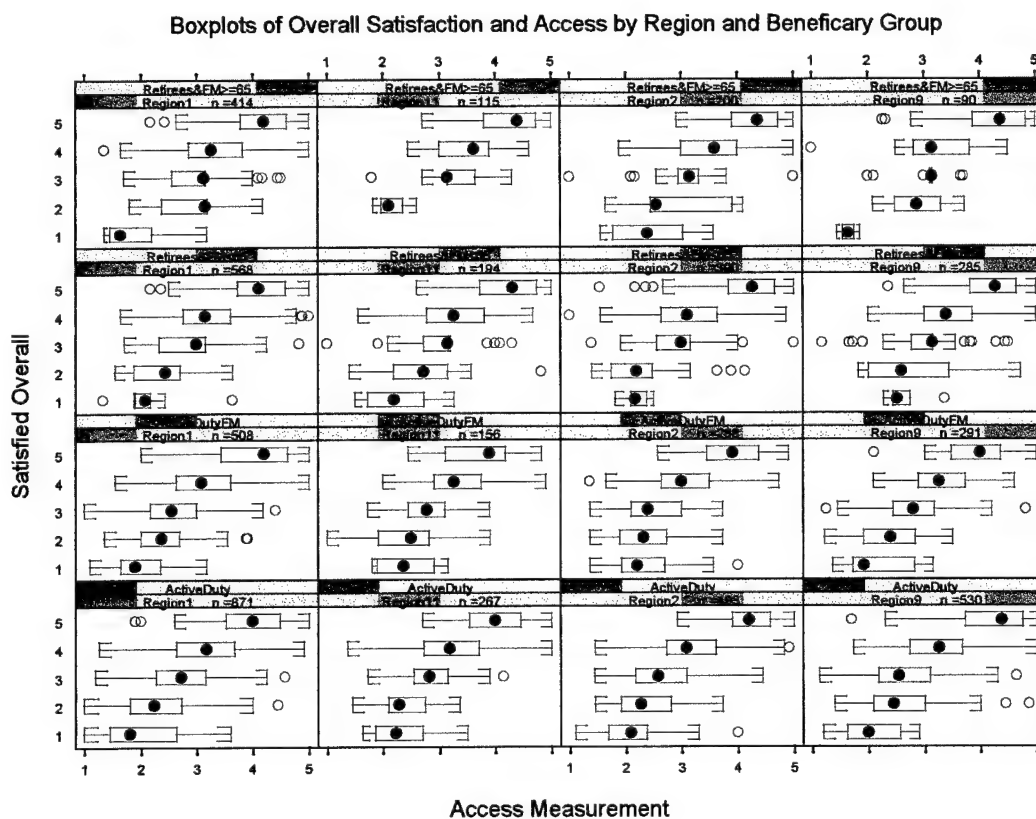


Figure 12 Relationships of Variables with Few Interactions.

This figure demonstrates a set of variables that have few or no interactions among variables. Interactions are seen as different slopes of panels as the eye moves through the conditional variables. In row 1 of Figure 12, as the eye moves from left to right, there seems to be very little interaction occurring between regions. Each region has approximately the same shape and slope of the medians (dots within the boxplots) and the sizes of the boxes are about the same, indicating similar distributions of the interquartile ranges. When looking at a specific region such as Region 1, panel (1,1) and panel (1,2) appear to be approximately the same, indicating little interaction or interdependency within Region 1 among beneficiaries between beneficiary groups in the first two groups and the relationship between *access* and *overall satisfaction*. Identifying groups of variables that do not have interactions may help the decision-maker understand relationships which can be explained relatively easily. For example, as *access* increases, the rating of *overall satisfaction* by respondents in Region 1 who are active duty or family members of active duty will increase by approximately the same amount. In other words, if a military facility would like to increase overall satisfaction, then there is consistent relationship between that variable and *access*.

In the 1994-95 survey, *access* was rated as the lowest measurement indicating it was one of the most dissatisfying aspects of care for beneficiaries. For the 1996 survey, *choice* was rated the lowest and *access* moved to the third-lowest measurement, pointing to some improvement. The *finance* measurement was rated as the second lowest measurement on the 1996 survey. The measurement consists of two questions: 1) "Protection you have against financial hardship due to medical expenses" and 2) "Help with arrangements to get

the health care you need without financial problems.” Figure 13 is the graph of *satisfied overall* modeled by *finance* conditioning on *regions* and *beneficiary groups*.

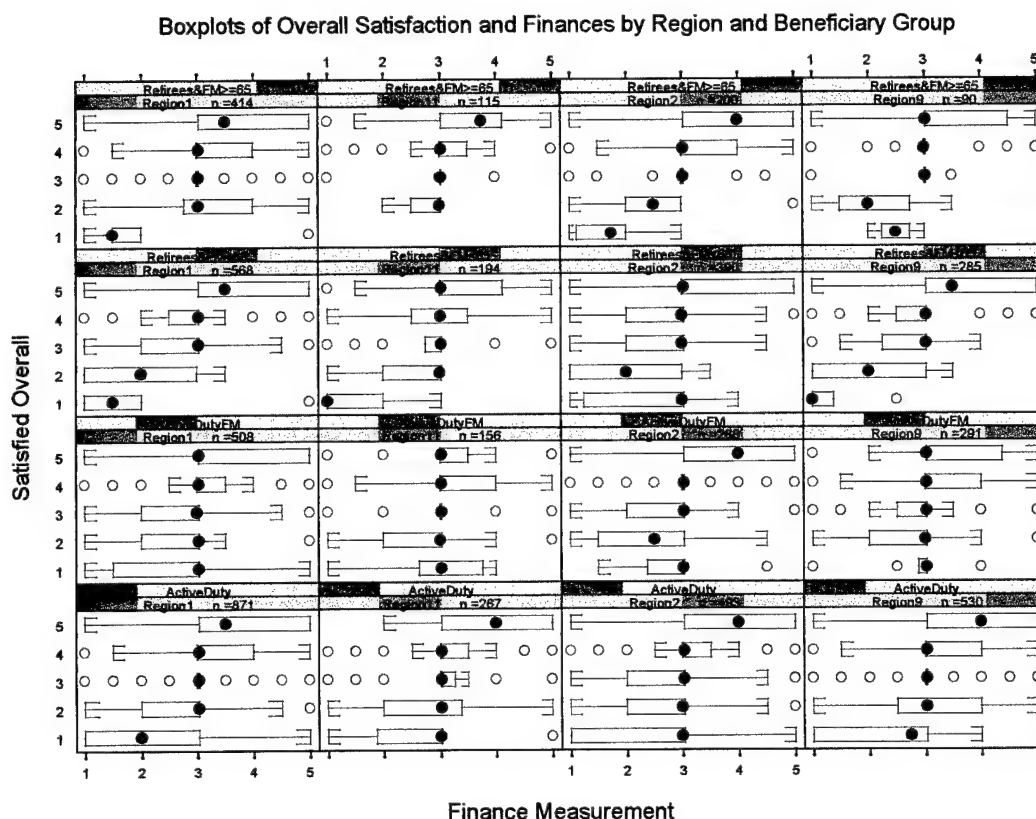


Figure 13 Relationships of Variables with Interactions.

This picture is very unusual because in almost every panel by *region* and *beneficiary groups*, the *finance* measurement has a median of 3. The response by active duty members, who should feel that the military will cover their own medical expenses was expected to be higher than 3. Instead, this group has several of the ratings across regions that were lower than the median value of 3. This could indicate that when thinking of financial security, these active duty members might be describing their security as it relates to their families,

not as individuals. In column 3, which is Region 2, there are some interactions occurring between the beneficiary groups, while there appear to be only minimal interactions occurring in Region 11.

Figures 14 and 15 are graphs of *overall satisfaction* modeled by the *choice* measurement by *region*, *beneficiary group* and by *sex* (Figure 14: female, Figure 15: male).

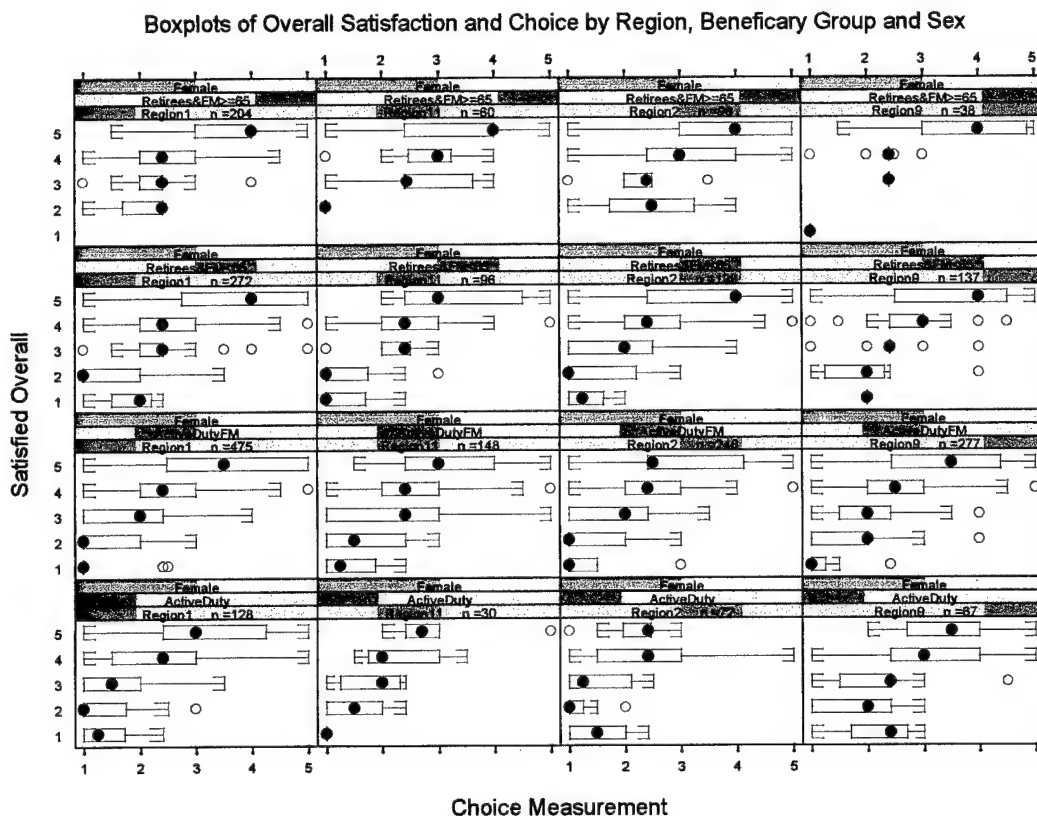


Figure 14 Interactions among Choice Variable for Females.

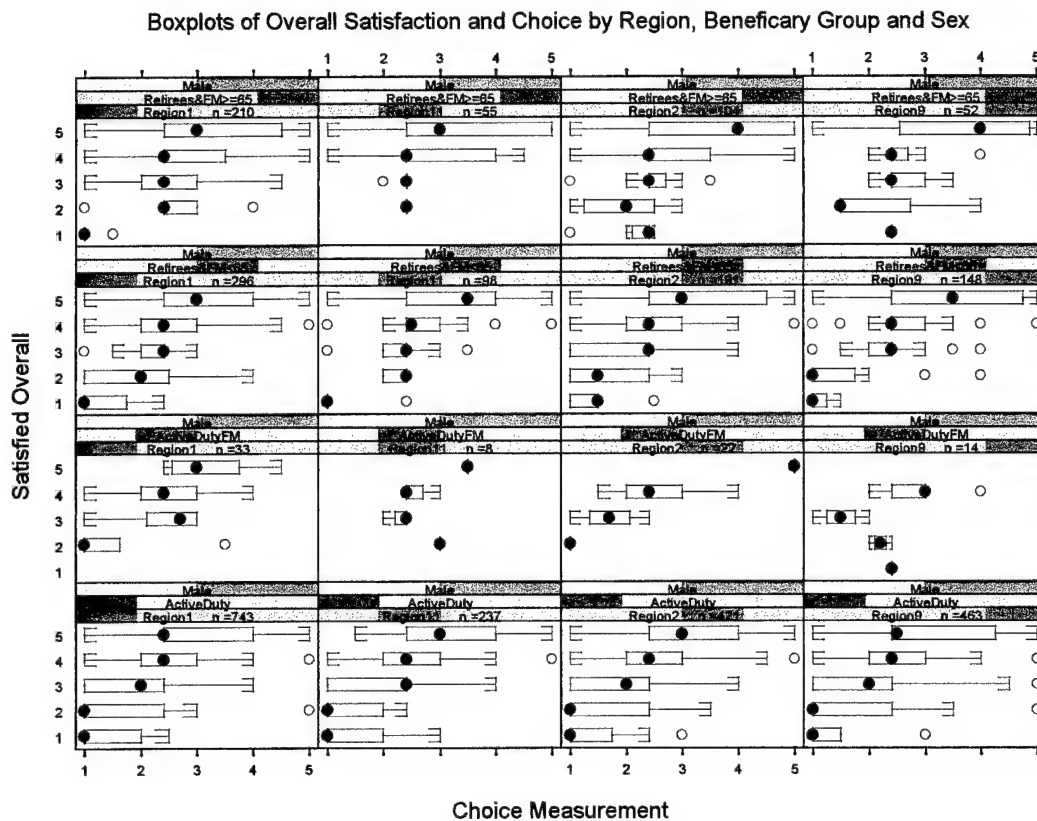


Figure 15 Interactions among Choice Variable for Men.

The *choice* variable had the lowest mean satisfaction score of all of the HEDIS measurements. The variable is defined by the questions: 1) “Ability to choose health care providers” and 2) “Ease of seeing the provider of your choice.” This variable relates to what are really two separate issues, choice of provider and continuity of care. There are many interactions going on between beneficiary groups as seen, for example, by starting at the bottom of each column and going up, holding the region constant. This is also true among the different beneficiary groups across regions. In Figure 14, there are very few females who rate choice above the value 3. The active duty females seem to be very unhappy in Regions 2 and 11 and only slightly happier in Regions 1 and 9.

#### 4. Complex 5-Way Interactions

Figures 16 through 19 are a set of 4 pages for a 5-way interaction with *overall satisfied* as the response variable. *Choice* is the continuous explanatory variable and the conditional variables are *communication*, *region* and *beneficiary group*. Each of the four figures represents a beneficiary group beginning with active duty members. Below is Figure 16, which shows the active duty members for each region.

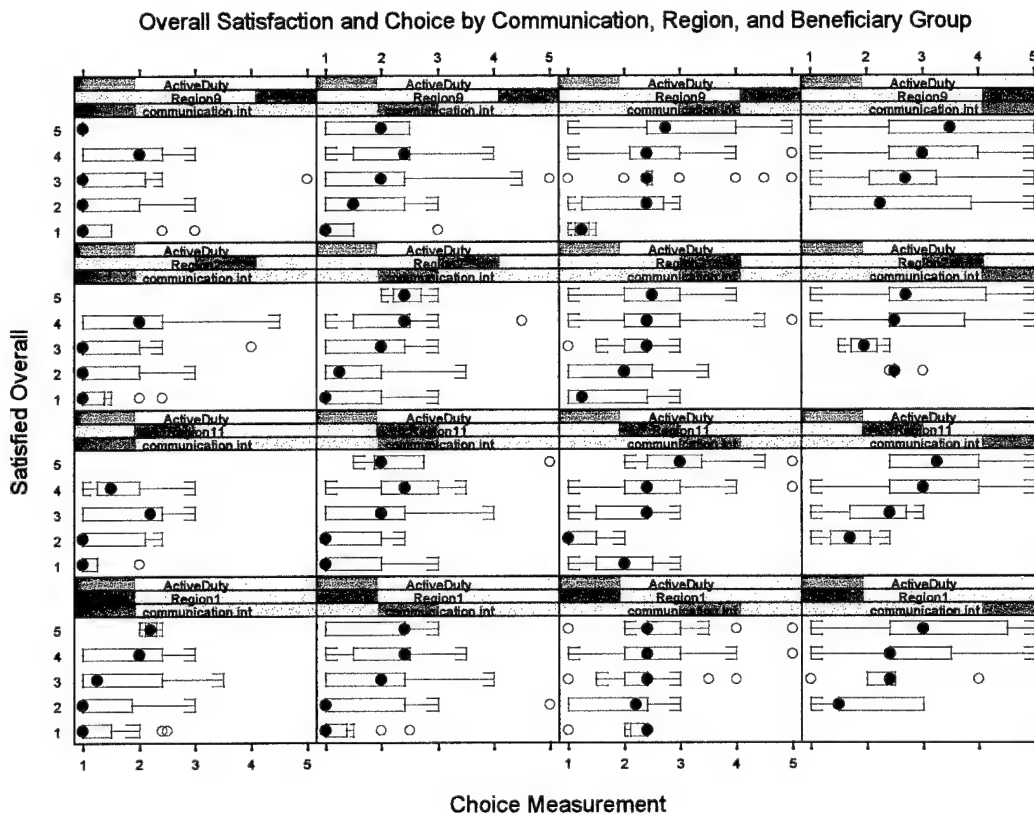


Figure 16 5-Way Interactions for Active Duty Members.

Each row on each page shows how choice is modeled by *overall satisfied* holding *communication* constant for one-point intervals. Each column on each page is a comparison

of *regions* for each level of *communication* while *choice* and *overall satisfaction* are the response and explanatory variables. The level of interaction on these four figures are very complicated and difficult to interpret; however, Trellis provides the ability to see movements within the conditional variables which may lead to insights of multi-level interactions among variables.

In Figure 16, columns 1 and 2 depict the first two levels of *communication* as is shown by the shaded portion of the strip label. As each level of communication progresses up one interval, interactions are occurring within each region. Figure 17 shows the interactions for active duty family members. There appear to be interactions for all levels of *communication* except the 4 to 5 intervals for *communication* in column 4. The slopes seem to be approximately the same although there are *overall satisfaction* levels that do not have any observations such as in Region 11 and Region 9. Active duty family members' responses also appear to have rated *choice* lower than the corresponding levels of *communication* which is shown by the ratings in almost all of the panels being to the left of the shaded bar that indicates what level of *communication* is being measured. This shows the same results as the dotplots which is to show that *choice* is rated lower than *communication*.

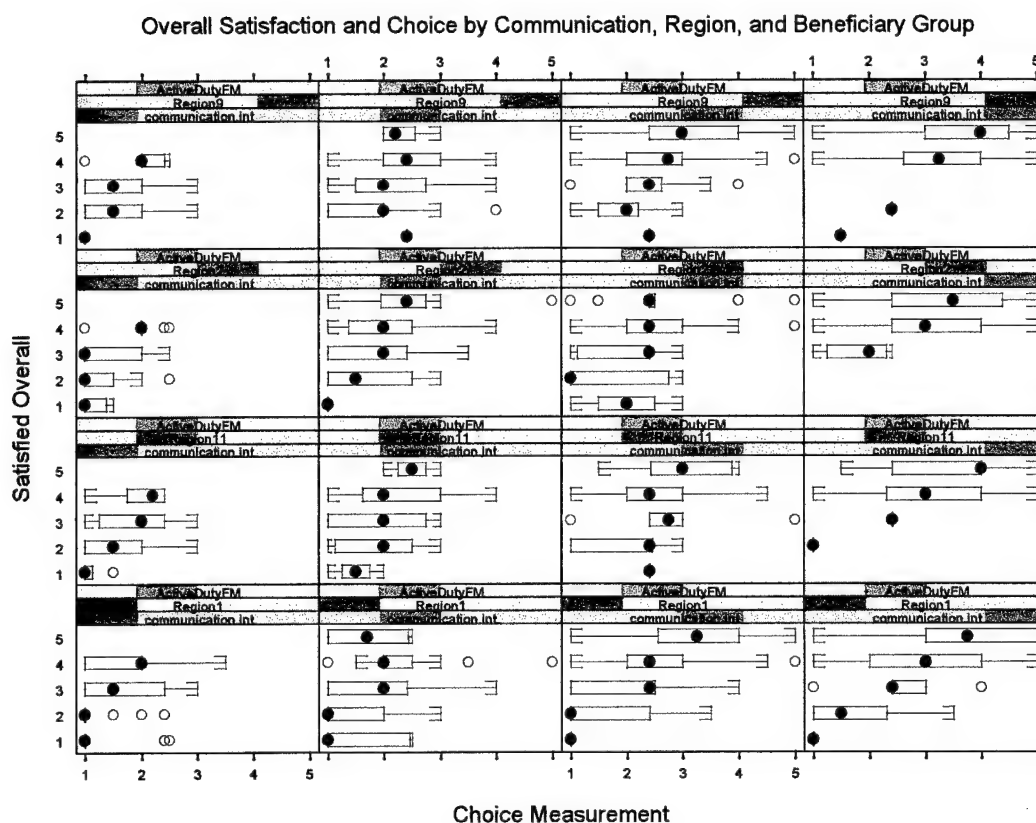


Figure 17 5-Way Interactions for Active Duty Family Members.

Next, Figure 18 of retirees and their family members less than 65 year old, shows interactions throughout the page, with one possible exception of the slopes of the *communication* interval from 2 to 3, which look similar in column 3.



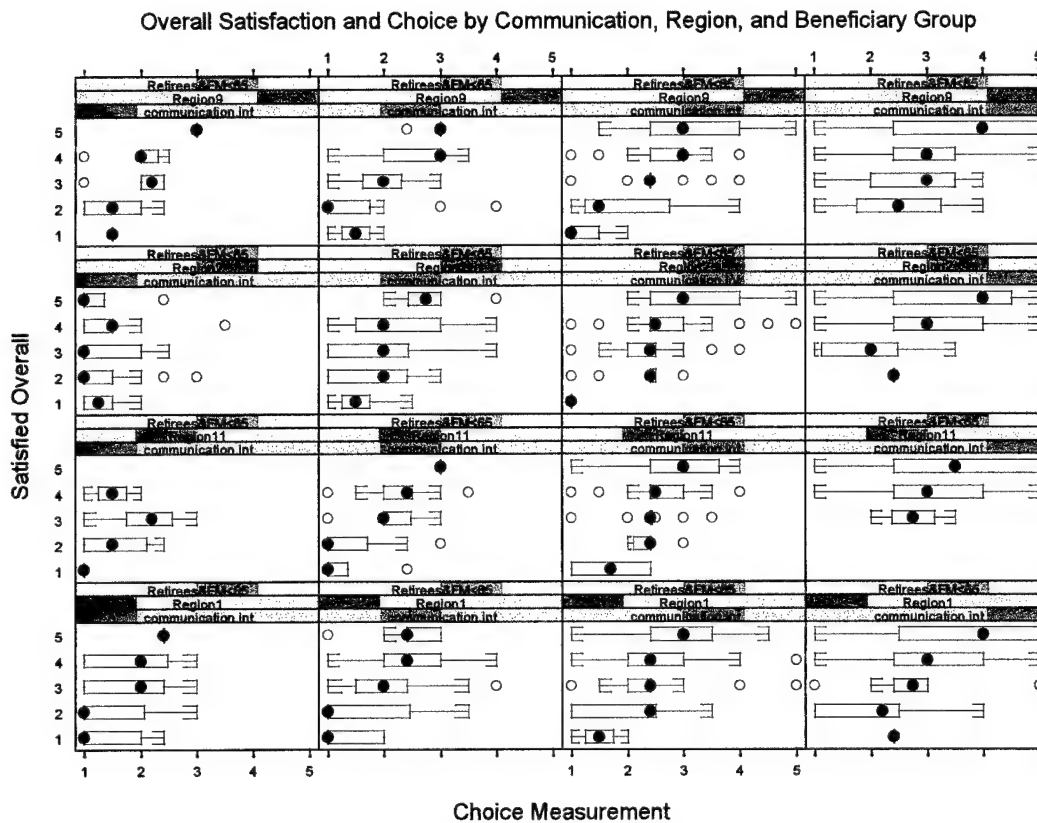


Figure 18 5-Way Interactions for Retirees and Family Members < 65.

The final beneficiary group in this example showing multi-panel interactions is the retirees and their family members who are age 65 years and older. This group had the highest median of overall satisfaction, reflected by the small number of observations in column 1 of Figure 19. But even in this group there are still the ratings of *overall satisfaction* given *choice* that are lower than the defined interval for *communication*.

These four graphs of 5-way interactions are difficult to interpret unless there is some expert who is knowledgeable about the specific beneficiary groups within each region. In this type of situation, the complex interactions could provide more insight into the attitudes that are expressed through the survey.

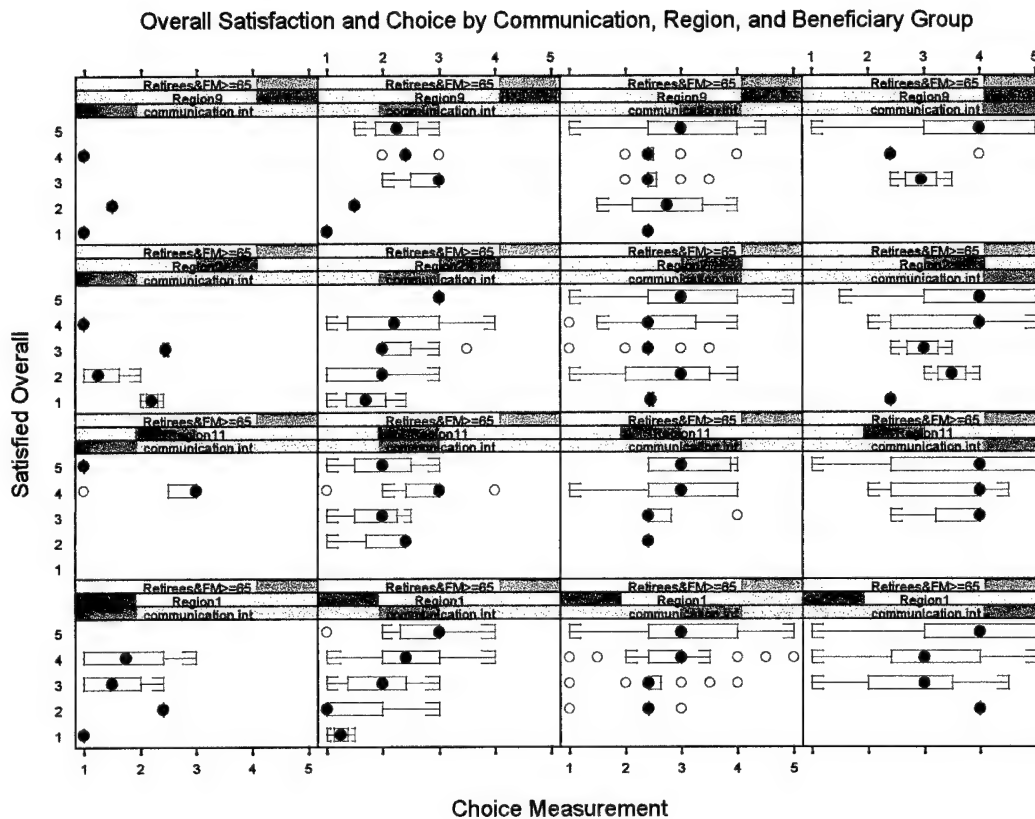


Figure 19 5-Way Interactions for Retirees and Family Members  $\geq 65$ .

## 5. Overview of all 14 Regions

Figures 20 and 21 provide a comparison of the satisfaction scores for all 14 regions. In Figure 20, the two groups that have the lowest median are active duty members and active duty family members. The region having the lowest median is Region 3 and the region that has the highest median is Region 5. The general trend of women being less satisfied with healthcare is carried through most of the regions. However, there is one exception to this for one of the beneficiary groups in Region 5. Active duty males appear to be noticeably less happy than the females as shown in panel (7,2). Choice

remains as the lowest measurement across all regions and active duty females in Region 12 are shown in panel (5,1) as being the most dissatisfied.

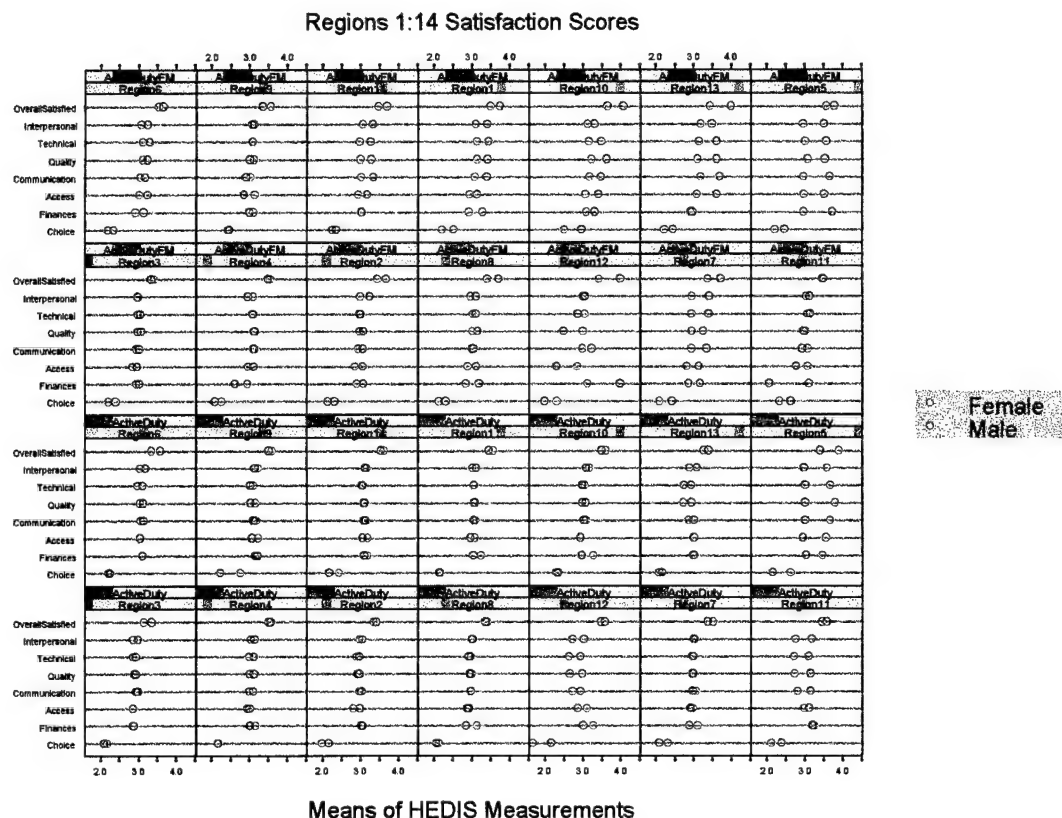


Figure 20 Regions 1:14 Active Duty and Their Family Members Groups.

Figure 21 shows that the beneficiary groups that have the highest median for all of the regions are the two retiree groups. Here the same general trends are seen as before with the measurements *choice* and *overall satisfied*. Retirees across all regions are much more satisfied with healthcare than active duty members and their families.

The explanation for this occurrence may be due to the self-selection of retirees and their family members in wanting to have access to the Military Treatment Facilities. These two groups of beneficiaries have the least availability and access to care; when

they do gain access, they are likely to be extremely satisfied with that episode of care. In contrast, active duty members are directed to go primarily to the Military Treatment Facilities and do not generally have a choice in the location of where they may receive medical care. Active duty family members do have a choice in selecting the location of care, but may be constrained by financial concerns in those regions that did not have TRICARE, or may be unhappy with their situation in those regions that did have TRICARE.

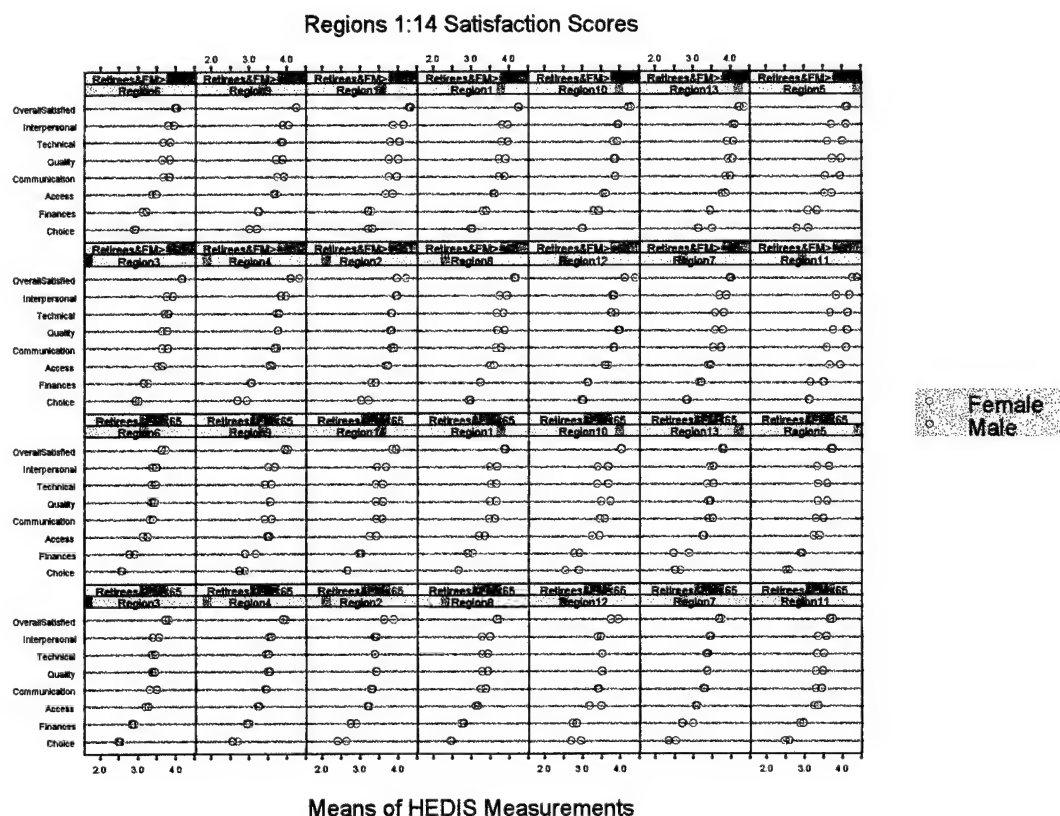


Figure 21 Regions 1:14 for Retirees and their Family Members



## **VI. CONCLUSIONS**

### **A. DISCUSSION**

The primary objective of this paper was to determine if any of the HEDIS measurements would indicate areas among patient satisfaction scores that could be used by decision-makers to improve patient satisfaction. In addition to understanding these seven areas, another important question was whether there are differences in satisfaction between men and women or between the four beneficiary groups.

First logistic regression was used to model overall satisfaction by the seven HEDIS variables and by the demographic variables used to describe the respondent population. Although this technique provided insight into the complexities of the data, it raised more questions than answers. One could just conclude that all of the variables and interactions among variables are significant. The problem with this approach is that just determining that all of the variables are important, indicated by the largest coefficients, does not describe the data properly or explain the negative coefficients for the main-effects models. The relationships among the variables were strongly interdependent and to understand them and how to improve patient satisfaction, that assumption is not enough, so an additional analytical approach was needed.

The Trellis Graphic framework provided an excellent tool to visualize and understand the complex relationships between variables and the interactions of variables. One of the most important findings is that overall satisfaction is not an accumulation of the seven HEDIS factors because the overall satisfaction measurement was rated consistently higher than any other variable. It was expected that overall satisfaction would be approximately an average of the variables that define it. A possible explanation could be related to the positioning of the question. The question concerning overall satisfaction

with the health care appeared in the survey before the specific questions concerning access, technical, quality, choice and continuity, communication, finances, and interpersonal skills. There seems to be a design effect created by the order of the questions on the survey that leads respondents to answer to this early question more positively than to the other questions that make up the HEDIS variables. If a decision-maker were to use only this score as an indicator of patient satisfaction, his or her audience could potentially be misled.

The results of the Trellis graphics for the four defined regions suggests that across beneficiary groups the measurement that can have the greatest impact on improving patient satisfaction is *choice*, which includes continuity of care. In a study conducted for Kaiser Permanente of Northern California, it was found that choice in choosing one's own primary care manager was the single most important factor in overall satisfaction (Greene 1998). This analysis would indicate military beneficiaries are not much different from their counterparts in the civilian health plans in regard to wanting to choose their own doctor and have continuity of care. Active duty members rated choice in the lowest ranges of the scale, indicating their extreme unhappiness with their ability to choose their provider. In the past, there has been anecdotal evidence to suggest that there is a feeling among active duty members that they have less choice than dependents and retirees do. This analysis clearly indicates this perception by the active duty population through their low ratings of *choice* in every region.

One answer to this problem might be the TRICARE program. TRICARE was developed as a combination of the strong points of the civilian sectors' managed care plans to provide patients with better access, choice and quality of care. Under

TRICARE, active duty members are automatically enrolled in TRICARE Prime, which means they are mostly enrolled at the military treatment facilities. Regions 9 and 11 had substantial experience with TRICARE at the time this survey was conducted but Regions 1 and 2 had not begun the TRICARE program. There did not appear to be a consistent difference in ratings between regions that had TRICARE and those that did not, possibly indicating that TRICARE does not have an effect on how patients are managed within the military treatment facilities. However, further studies would be needed to examine the degree of interaction between these variables.

In response to the question of whether there are differences in satisfaction between men and women, the answer is yes. There are some exceptions such as in Region 9, where active duty males were less satisfied in almost every measurement than females, but the primary trend was that women are less happy than men across beneficiary groups and regions. This was particularly true for Regions 1 and 11. Research done by Gregory Pascoe (1983) indicated that in general females tend to be more happy than men, which is opposite of the findings for these four regions for military treatment facilities.

Studies have shown that older patients tend to be happier than younger patients, and this analysis agrees with those findings. The oldest beneficiary group, retirees age 65 and older was the most satisfied group across all regions. This was not what was initially expected since this group of beneficiaries fall under Medicare and have the lowest level of accessibility to military treatment facilities. However, since they have been able to gain access, they seem to be extremely happy with the care they have received, possibly because the healthcare is perceived as high quality while requiring little or no out-of-pocket expenses.



On a final note, this analysis and the resulting conclusions would not have been possible without the use of the Trellis Graphics framework. This graphing technique provided a new way to look into hypervariate data and break the barrier of graphing for up to three dimensions. This would have been impossible only a few years ago. This technique will revolutionize the way multivariate data sets can be used when other statistical techniques are limited by interdependencies among variables. Trellis Graphics can be especially useful in understanding complex behavioral surveys, like the DOD Annual Survey, that typically have discrete ordinal scales. Trellis's strength lies in its seemingly simple, easy to read graphs that make the analysis of complex data understandable. This method was extremely useful in comparing multiple demographics of subgroups of beneficiaries that enabled additional insight into trends among HEDIS measurements for age and sex. Real-life data measuring attitudes and feelings often have complexities and interdependence that restrict the use of statistical tools such as logistic regression. The Trellis graphics allowed the visualization of the interactions that the logistic regression models were capturing but not explaining.

## **B. RECOMMENDATIONS**

The military treatment facilities are the primary location of care for active duty members, yet this beneficiary group was the least satisfied for almost every HEDIS measurement. This indicates that there is a perception among active duty members, not held by the retiree groups, that health care in the military treatment facilities is inadequate. Since the active duty group is the primary customer of military treatment facilities, it is recommended that further studies be conducted to pinpoint the reasons for these perceptions.

The second recommendation is to include a question on overall satisfaction at the end of the 32 HEDIS measurement questions identical to the one at the beginning. This may allow for a different measurement of overall satisfaction and would also measure the effect of asking the question twice to see if there is a large variation in responses caused by the intervening HEDIS measurement questions.

The third recommendation is to delete the NA options on the 32 questions on patient satisfaction. By providing that option, analysis of the questions is affected because many statistical tools handle them by deleting each response with any NAs. This has the effect of decreasing the number of responses by up to approximately 50%.

The final recommendation is to explore the use of Trellis Graphics for individual catchment areas. Valuable information can be obtained from seeing and understanding the responses of patients who have used a specific hospital; this would provide information and understanding to decision-makers at the lower levels.



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